

An Overview Study of the Yellowknife River Basin N.W.T.



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An Overview Study of the Yellowknife River Basin N.W.T.

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Cover Photograph: Cameron River Falls

Photograph by: Brian Olding, Water Quality
Branch, Yellowknife

Abstract:

This report places basin water resources in the context of basin geology, physiography, climate and vegetation. Current land use is examined and analysis is made of historical and 1987 reconnaissance water resource data. Eight recommendations are directed toward improved management of basin water resources. A principal conclusion is that Yellowknife basin waters have been little changed from their original state in terms of pH, conductivity and metal contaminants. Another conclusion, of significance to future management strategies, is that the system is amenable to modelling of streamflow and water level.

Résumé:

Ce rapport a étudié les qualités hydrologiques du bassin versant de Yellowknife selon ses caractéristiques géologiques, physiographiques, climatiques et végétales. De plus, l'utilisation des terres a été examinée. Les données historiques, ainsi que celles provenant d'une étude de reconnaissance de 1987, ont été analysées.

Cette étude suggère huit recommandations concernant l'amélioration de la gestion des ressources en eau. La principale conclusion est que le bassin versant de Yellowknife a subi peu de changement des caractéristiques originales du pH, de la conductivité et des contaminants par les métaux lourds. Une autre conclusion, en rapport aux stratégies futures de la gestion du bassin, établit que la simulation du débit et du niveau d'eau est possible.

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1.0 INTRODUCTION:

This report is one of a series of river basin overviews prepared by Inland Waters Directorate, Environment Canada which describe basin water resources in the context of land forms and water use. They are intended as background documents for development of detailed plans to manage basin water resources in an environmentally sound manner.

The Yellowknife River basin has been selected for study because of the current and anticipated future use of the basin's resources for recreation, mining, hydroelectric power production, and water supply for the city of Yellowknife. The basin overview is also seen as complementary to a study by Indian and Northern Affairs Canada of the impacts of historical waste discharges on the aquatic environment of Yellowknife and Back bays at the outlet of the Yellowknife River.

Assessments by the NWT Water Board Environmental Advisory Committee, Water Resources Division, DIAND; Inland Waters Directorate, DOE; and the NWT Department of Renewable Resources suggest that a more comprehensive study is warranted. An interagency basin planning study proposal is currently being prepared for consideration.

The objectives of this study were to compile information for basin water resources, for geophysical elements of the land and for historic, existing and potential socio-economic elements in the basin. Linkages between the water resource and other elements are described in order to assist in the future development of basin water management plans.

The report concludes with recommendations on data requirements, management and environmental issues. They constitute suggestions for consideration in future planning studies for the Yellowknife River basin.



FIGURE 1. LOCATION OF THE YELLOWKNIFE BASIN IN CANADA

2.0 ELEMENTS OF THE LAND:

2.1 Location:

The Yellowknife River basin is a medium-sized catchment, just over 15,000 km², which drains into Yellowknife Bay of Great Slave Lake near the city of Yellowknife. The basin lies between 62° 20' and 64° 20' North latitude and between 112° 10' and 114° 40' West longitude. The general trend of the basin and the river mainstem is south by southwest. Figure 1 shows its location within Canada and Figure 2 provides some details on the drainage network within the basin.

2.2 Physiography and Surficial Geology:

The Yellowknife River basin lies near the northwestern margin of the Canadian Shield in the Bear-Slave upland. Local relief in the basin is modest because it is part of a granatoid and metamorphic terrane that has formed a stable block or craton for the past 2 billion years of earth history. Thus it has been planed down by eons of weathering and erosion that culminated in a million years of intense continental glaciation during the Pleistocene which removed most weathered rock and soil, laying bare extensive areas of fresh bedrock.

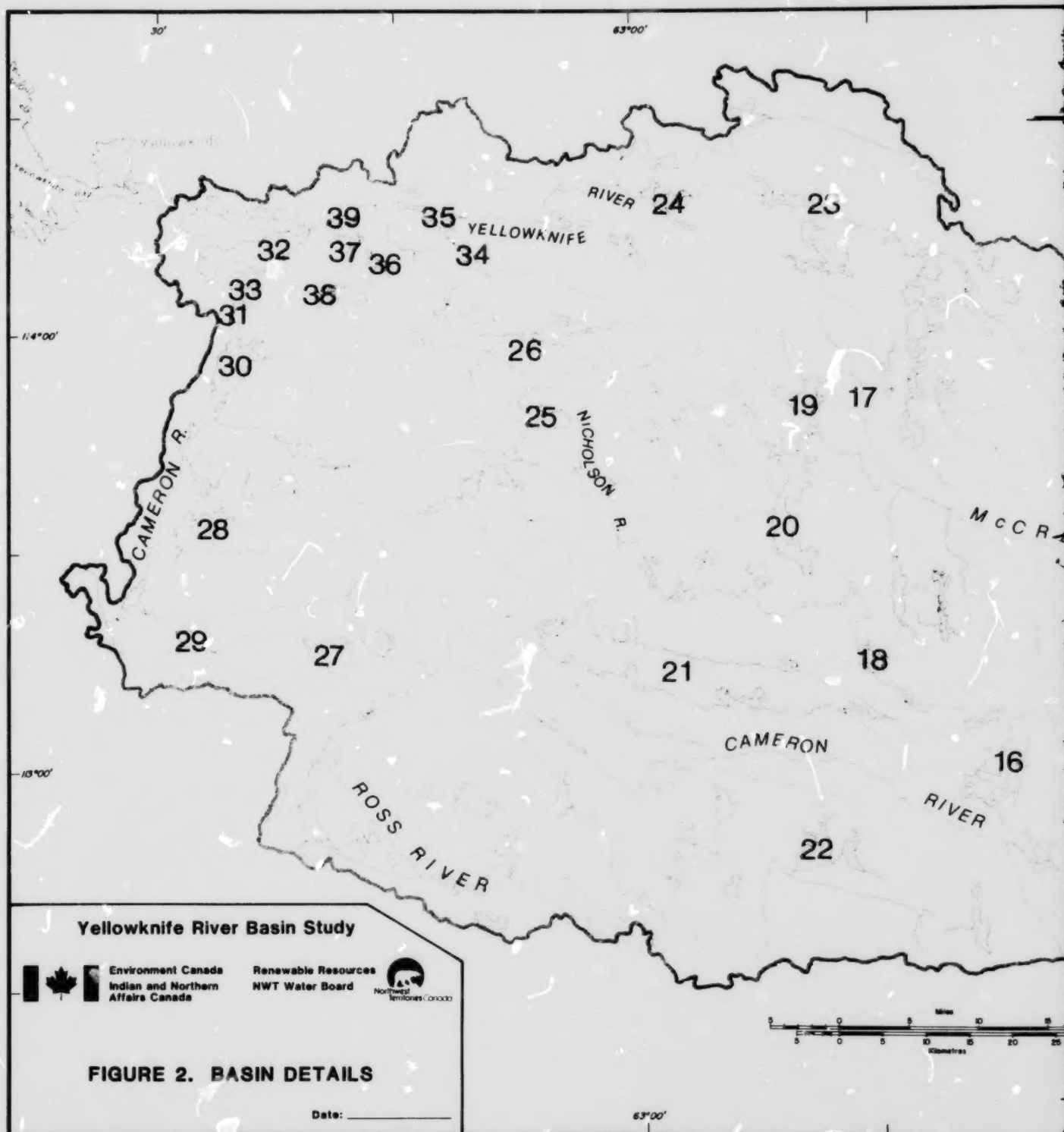
During most of the last advance of the Laurentide ice sheet, the Yellowknife River basin was in a sub-ice erosional regime that produced a terrain of areal scour with ubiquitous erosional land forms and rare tills (Aspler, 1979).

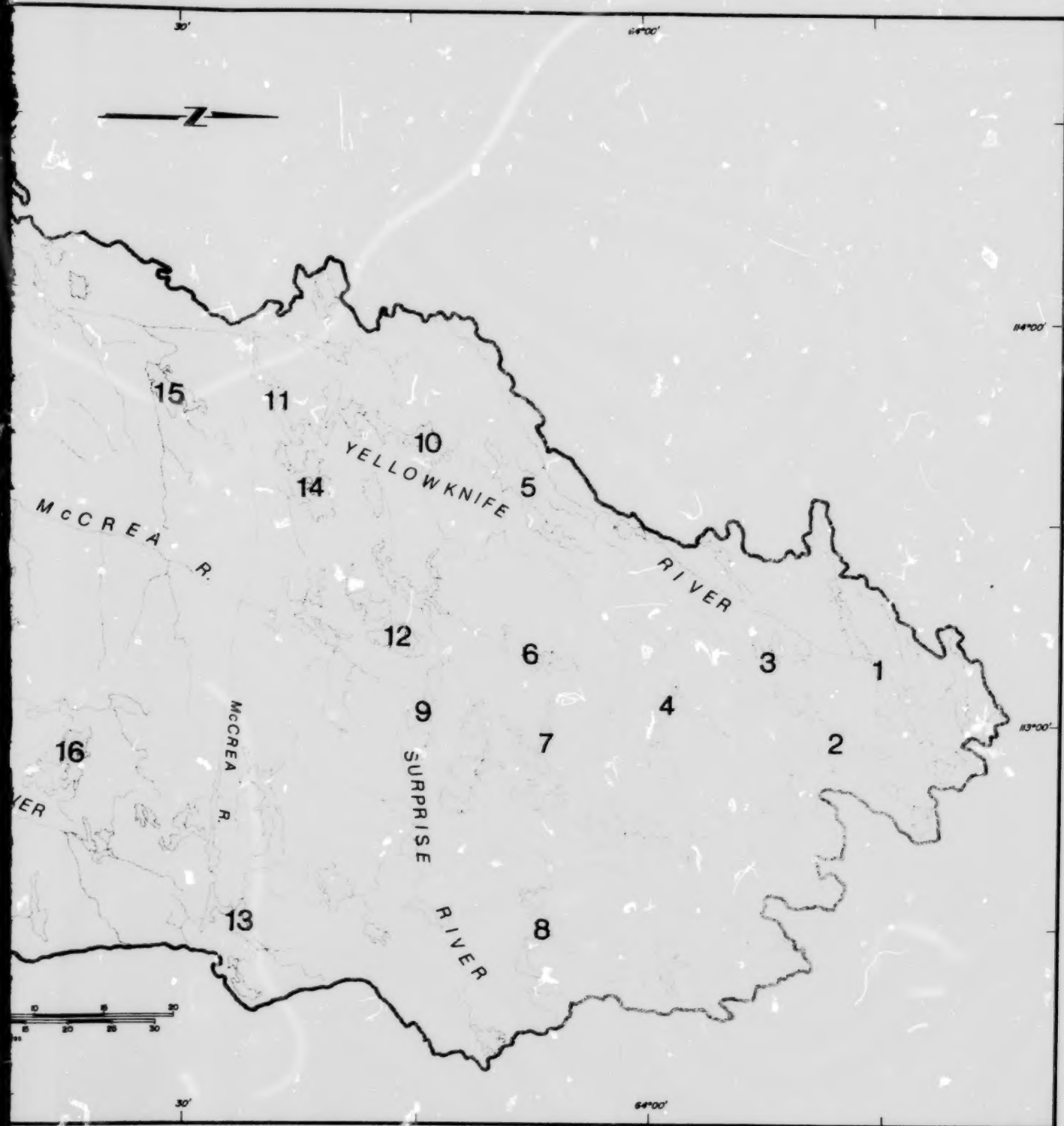
Following deglaciation, 10,000 - 8,000 before

Figure 2: Yellowknife River Basin Detail

LIST OF LAKES

- | | |
|---------------------------------|--------------------------------|
| 1. Greenstockings Lake | 21. Gordon Lake |
| 2. Grizzle Bear Lake | 22. Agassiz Lake |
| 3. Orkney Lake | 23. Fishing Lake |
| 4. Thoolezzen Lake | 24. Rocky Lake |
| 5. Reindeer Lake | 25. Graham Lake |
| 6. Squalus Lake | 26. Duncan Lake |
| 7. Sharples Lake | 27. Ross Lake |
| 8. Prang Lake | 28. Hidden Lake |
| 9. Boulder Lake | 29. Tibbett Lake (not visible) |
| 10. Upper Carp Lake | 30. Prelude Lake |
| 11. Lower Carp Lake | 31. Pontoon Lake (not visible) |
| 12. Thetis Lake | 32. Prosperous Lake |
| 13. McCrea Lake | 33. Madeline Lake |
| 14. Frodsham Lake | 34. Angle Lake |
| 15. Nardin Lake | 35. Quyta Lake |
| 16. Brown Lake | 36. Drygeese Lake |
| 17. Nicholas Lake (not visible) | 37. Baptiste Lake |
| 18. Smokey Lake | 38. Alexie Lake |
| 19. Giauque Lake | 39. Bluefish Lake |
| 20. Thistlethwaite Lake | |





present (BP), the area was at least locally exposed, and sands and gravels deposited in some of the valleys. With the rise of glacial Lake McConnell to 275 m above the present level of Great Slave Lake, large areas of the Yellowknife River basin were inundated. Glacial materials were worked by wave action in this huge glacial lake, washing most of the fines from materials along the gradually dropping shoreline and leaving sands on topographic highs and silts and clays in low areas. For this reason hill tops are now covered by boulders or glacial erratics, and glacial tills are found in valleys, where they are buried by a blanket of wave-sorted sand, silt or clay. Aspler (1979, 1987) summarizes the glacial history and surficial geology.

The basin is near the northern border of the belt of discontinuous permafrost (Brown, et al, 1981) which is widespread in areas of silts and clays, and sporadic in well-drained sands and gravels. Permanently frozen silts and clays contain ice lenses and are thaw-unstable whereas permanently frozen sands and gravels are thaw-stable. Permafrost is probably continuous in the northern parts of the basin, which lie in the barren lands.

See Figure 3 for details.

2.3 Geology:

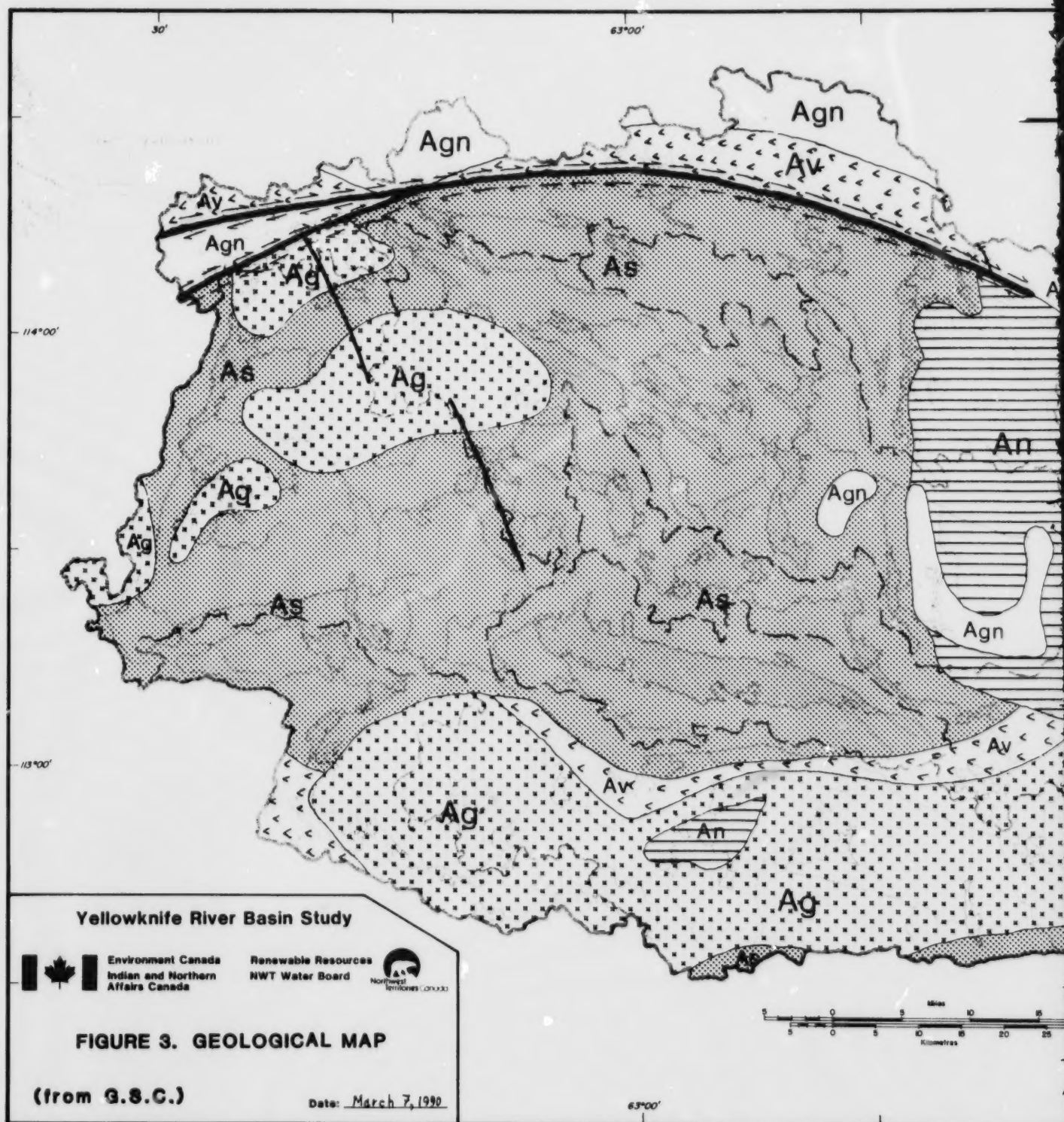
Bedrock of the Yellowknife River basin (Fraser, 1969; Henderson, 1985; Moore et al, 1951; Yardley, 1949) is essentially volcanic and sedimentary rock intruded by Archean batholiths and plutons to produce a granitic-metamorphic terrane. The southern half of the basin is dominated by the Yellowknife supracrustal

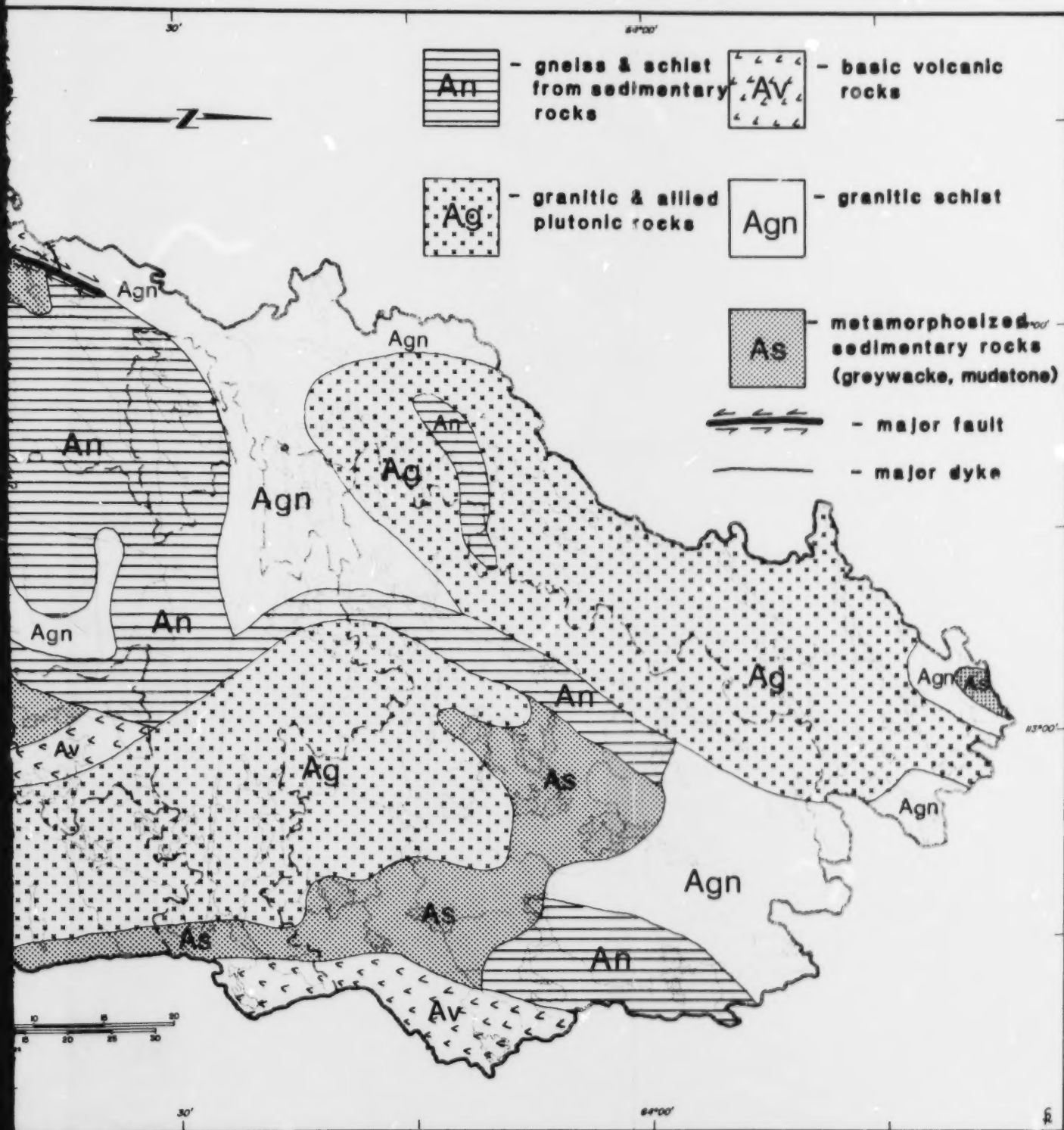
basin, mainly turbidite metasediments. In places, thick sequences of mafic to locally felsic volcanics occur, mainly between the sediments and granitoids.

Towards the northern part of the Yellowknife River basin, the sedimentary and volcanic rocks are so intensely intruded by granitic rocks that they seem to have been either totally consumed or converted into granitic gneisses (Padgham, 1986).

The turbidites are alternating sand-silt-mud layers produced from clouds of waterborne sediment that cascaded from the shores of surrounding uplands, including volcanic islands. The sedimentary basin is intruded by 'granite' associated with pegmatites, but the surrounding intrusions are of more granodiorite to dioritic composition. The youngest rocks are diabase dykes tapped from the mantle at various times between 2.5 to 1.2 billion years BP (McGlynn and Henderson, 1972).

So far, only the gold deposits of the Yellowknife River basin have been economically viable to develop. Auriferous quartz veins are abundant and widespread in the turbidites, but few of these make ore bodies. An exception was the Discovery deposit on which the only profitable mine in the basin was developed. Many deposits including, but not exclusively, turbidite-hosted quartz veins were being explored in 1988. Recent work suggests that deposits associated with granitic rocks, eg. Nicholas Lake northeast of Discovery and others in dioritic sills, eg. Viking, south of Discovery, have significant potential.





2.4 Impacts of Physiography and Geology on Surface Waters in the Basin:

The effects on watercourses of exposures of erosion-resistant bedrock and of glacial relic features are aptly described by Bostock (1968):

"The details of the tributary drainage, however, are disrupted by the local effects of glaciation including the tilting of the land surface, the grouping of the bedrock, and the deposition of surficial materials. Stream channels commonly follow elements of bedrock structure such as persistent fracture zones, major joint patterns, or the traces of soft strata; in places they are diverted across former divides dammed by glacial debris.

In many areas glacial movement transverse to bedrock topography and scattered deposition of glacial drift have formed a mosaic of ponds interspersed with small ridges and hummocks amongst which streams flow along tortuous courses. In contrast to this heterogeneous drainage, where drift deposits are scarce, the streams show a trellis drainage pattern, developed to various degrees, in which the main lines follow long straight lineaments, major fracture zones, or the dominant joint systems in the massive rocks. Differences in the resistance to erosion of the strata or

gneisses may also impress a drainage pattern....."

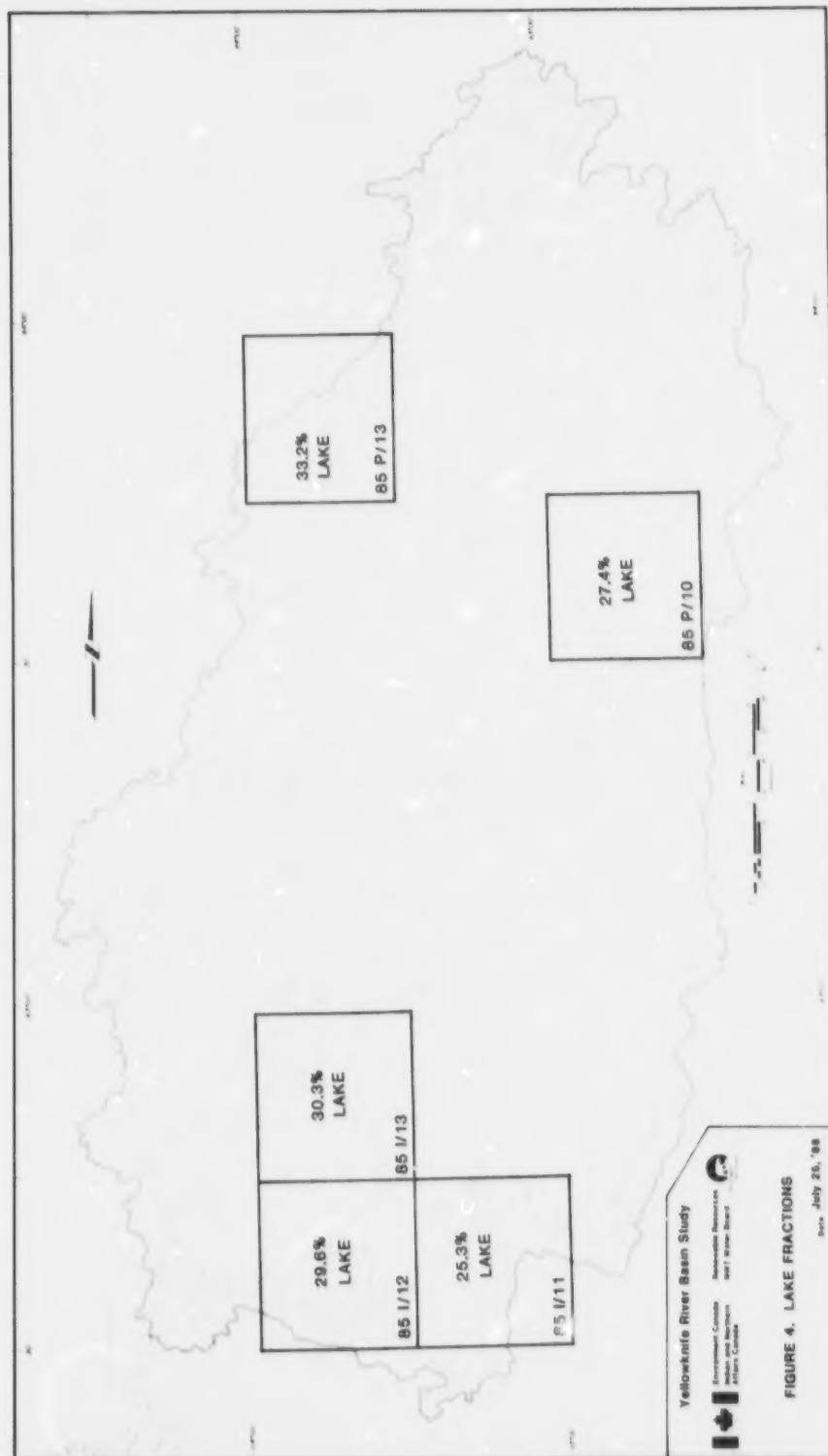
This extract from a generalized description of the Shield applies amazingly well to the Yellowknife basin in particular.

Basin elevations vary from 535 m at 64° 10'N, 112° 30'W in the extreme north to 156 m at the head of Yellowknife Bay in Great Slave Lake, a difference of approximately 380 m. Local relief, from the tops of rounded granitic hills to intervening valleys, is in the order of 100 m.

The hummocky rock surfaces formed by glacial action account for a very large number of lakes in the basin. Other lakes are the result of damming of depressions in the rock surface by glacial till, ground moraines, eskers and other unconsolidated surface material generated in the ice ages. Figure 4 shows surface water areas in five 1:50,000 map sheets as derived from a grid overlay sampling scheme. The data are shown in Table 1. Widespread storage in lakes and wetland generally acts to reduce the ratio of mean annual flood peaks to mean annual flow, and to maintain winter low flows at reasonably high levels. Storage also contributes to a lag period in the system's response to seasonal storm events or to mitigate the effects of unusually wet or dry seasons.

Several of the geologic features also influence basin hydrology. Evident in terms of surface water is the mid-basin circular feature when viewed on a mosaic of 1:50,000 scale maps shown at a greatly reduced scale

figure 4



NAME OF MAP	MAP NUMBER	n = total grid points	w = grid points on water	% WATER POINTS
ROSS LAKE	85 I/11	1804	456	25.3
PRELUDE LAKE	85 I/2	1760	473	26.9
DUNCAN LAKE	85 I/13	1760	533	30.3
ZIPPER LAKE	85 P/10	1716	470	27.4
WECHO LAKE	85 P/13	1634	543	33.2
MEAN OF FIVE SHEETS				28.6

Table 1. Lake Fractions in Five Selected Areas in the Yellowknife Basin

in Figure 5. Equally evident in Figure 5 is the impact on drainage pattern of faults, dykes and joint fractures; all of them linear features. It seems as if the circular feature fractured after its formation and the mainstem McCrae River now uses the long fault through its middle. Geology also influences the location of the mainstem and confines it to the western boundary of the basin for much of its length as is evident in Figure 2. The result of this is that all major tributaries enter the mainstem from the east or northeast.

2.5 Vegetation and Climate:

Most of the basin is located in the boreal zone where coniferous forest dominates. The lower 60% of the basin is part of the open woodland boreal sub-group, while the upper 25-30% of the basin is considered to be in the forest-tundra transition zone. The extreme upper reaches of the basin, about 10-15% of the area, are in the tundra zone which is defined by

figure 5



FIGURE 5. GEOLOGICAL FEATURES IN THE MIDDLE BASIN

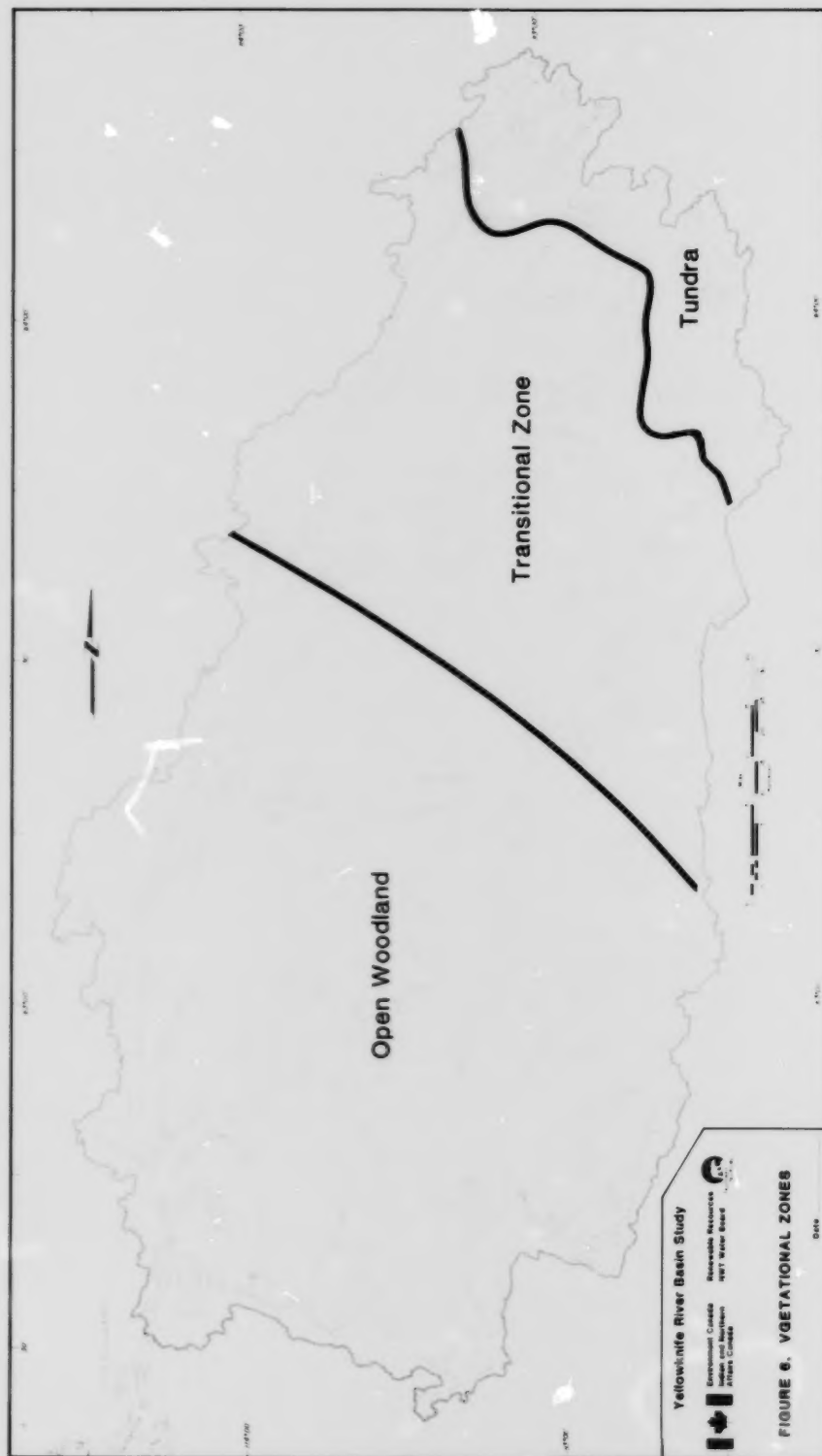
the tree line. The three zones are illustrated in Figure 6.

The open woodland is characterized by coniferous trees, birches, alders and a lichen floor. In wetland areas, black spruce, tamarack, willow and bog cranberries dominate. The forest-tundra transition area is generally made up of patches of coniferous trees alternating with lichen-heath and low shrubs. Tundra vegetation species are dominated by dwarf birch, spruce, willows, lichens and mosses. The wetland areas are vegetated by grasses, sedges and rushes.

The tree line also approximates the boundary between discontinuous and continuous permafrost and roughly corresponds to the -10°C annual isotherm. To the south and west of the treeline, the warmest month of the year, July, has an average daily temperature exceeding $+10^{\circ}\text{C}$. One definition of Arctic climate is that area in which the average daily temperature of the warmest month does not exceed $+10^{\circ}\text{C}$. It follows from this that the major portion of the basin which is under tree cover, can therefore be classified as sub-Arctic.

Some characteristics of the basin's climate have important hydrological implications. The precipitation is very light with an annual average of 200-300 mm, an amount equal to that of the driest regions of Canada's prairies. Approximately half of the average annual precipitation occurs as snow. Figure 7 illustrates this distribution of precipitation as derived from Yellowknife historical data (Bourque, 1988, pers. communication). In winter, alternate periods of short daylight and long hours of darkness combined with low

figures 6



sun elevation produce a prolonged period of net radiational energy loss from the earth's surface. As a result, the basin experiences a surface cover of ice and snow for as much as eight months of the year.

The extended period of snow cover greatly reduces the amount of absorbed solar radiation in the area. One result of this reduction in absorbed radiation is a relatively swift transition period from one season to the next during both the spring thaw and the fall freeze-up. The lengthy period of snow cover promotes the development of a strong temperature inversion above the snow and ice surface resulting in strong radiational cooling. This tends to perpetuate the snow and ice conditions, leading to a relatively swift transition from snow and ice cover to bare ground during the spring thaw. Thus the snowmelt in the basin is characterized by its rapidity which generates an intense, short runoff in first-order streams. This, however, becomes rapidly attenuated from storage of spring runoff in the innumerable lakes in the basin.

figure 7

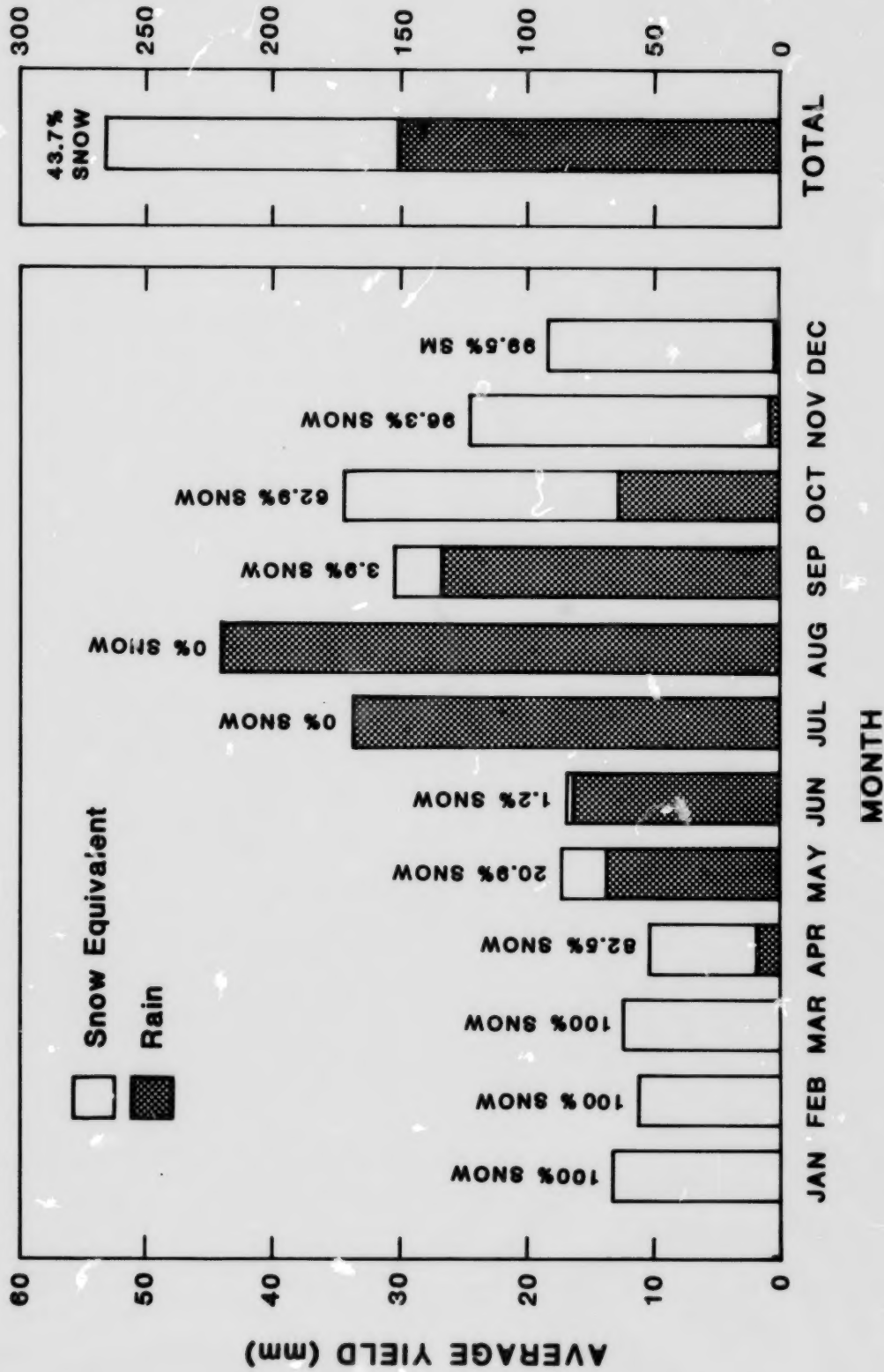


FIGURE 7. HISTORIC PRECIPITATION AT YELLOWKNIFE AIRPORT

photo page 1



Photo 1: A reach and rapids on the upper Yellowknife River, illustrating how the exposed bedrock determines the course of the stream.



Photo 2: A reach along the Cameron River.

3.0 CURRENT LAND USE

Dominant land-use activities in the Yellowknife River basin relate to mining and mining exploration, recreation, hydro-electric power generation and to harvesting caribou and fur-bearing animals

3.1 Mineral Development and Exploration:

- | | |
|------------------|--|
| Ptarmigan Mine - | In 1988, Treminco worked both of the old Ptarmigan and Tom mines and sent the NWT Water Board a plan to build a 200 ton/day mill in the area. Their preferred location is at the Ptarmigan property. |
| Giant Bay - | In 1986 Giant Bay Resources on Gordon Lake explored a low-grade ore deposit at Knight Bay. |
| Myrt Lake - | In 1987 Westfort Petroleum and Cameron Holdings were both active at sites on Myrt Lake. Westfort spent approximately \$500,000 on working old underground sites in 1987. |
| Dome Lake - | Lightening Minerals extracted ore in 1987 |

Details of mining activity and of exploration are difficult to obtain. With the exception of Treminco's Ptarmigan Mine, the other site activities listed are exploratory in nature. Most companies seem to be

looking at old sites that have been worked before and abandoned due to low-grade ores which are once more attractive. The operations are small, five to thirty men, and are probably only going to be in operation for three to five years. Most are near the winter road that goes to the Echo Bay property outside the basin on Contwoyto Lake. The proximity to road transport permits economical development of small properties who need to transport their ore for processing in the winter. Mine locations and access roads are shown in Figure 8.

There was fairly extensive exploration for gold in the Yellowknife River basin in 1987. High gold prices are expected to promote continued exploration and to bring about an increase in the number of small mines and developments. Because gold is susceptible to price swings in the financial market, high current levels of exploration and development activity will decline if gold prices were to fall substantially. Exploration and mining are also often perceived as being detrimental to traditional land uses. The resolution of land claims would enhance the opportunities for sustainable development of this important industry in the basin.

3.2 Recreation and Special Areas:

3.2.1 Regulated Land Use Areas:

Land use zoning regulations have been established in part of the Yellowknife River basin. The regulations, known as the Yellowknife Watershed Development Area Regulations are in effect for an area in the extreme southern region

Figure 8

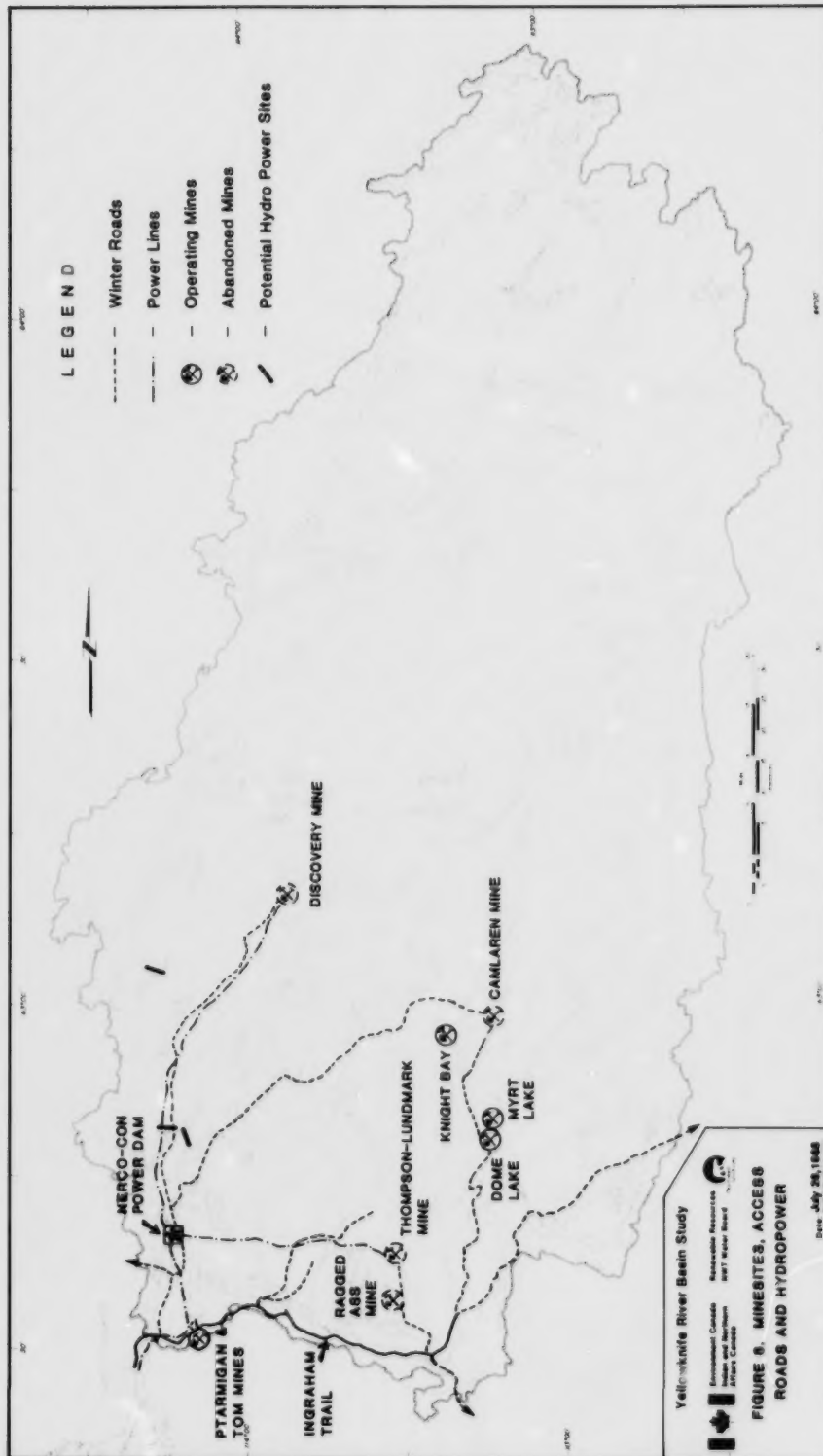


photo page 2



Photo 3: The Discovery Mines site showing the tailings fan into Giauque Lake.



Photo 4: A typical winter ice road in the Yellowknife River basin. Note meltwater forming over roadbed, lower right.

of the basin bounded by 62° 30' and 62° 45' North latitude and 113° 30' and 114° 30' West longitude as shown in Figure 9. The regulations divide the area into land use zones. Within the first zone the regulations prohibit construction of any building. In the second zone the regulations restrict the storage of petroleum products, restrict building sites within 15 m from water bodies, prohibit construction of permanent residences and require a permit for non-recreational land use. They also require minimum sewage treatment and provision for garbage and refuse disposal in pits. Finally, the regulations restrict land leases to a term of 20 years.

3.2.2 Adventure Tours:

The basin is not used extensively by adventure tour companies. The RCMP did not have any users register for the basin in 1987 and had only a few in 1986. Both the Cameron and Yellowknife rivers are used by small groups for canoe and kayak trips but the numbers are unknown. Typical usage is by weekend trippers out of Yellowknife. Tartan Rapids at the outlet of Prosperous Lake on the Yellowknife River, is an easily accessible stretch of white water used extensively by the local canoe/kayak association and by private individuals. Another popular river reach for weekend canoeing is on the Cameron River between Gordon and Tibbett lakes.

3.2.3 Lodges:

Katimavik Lodge:

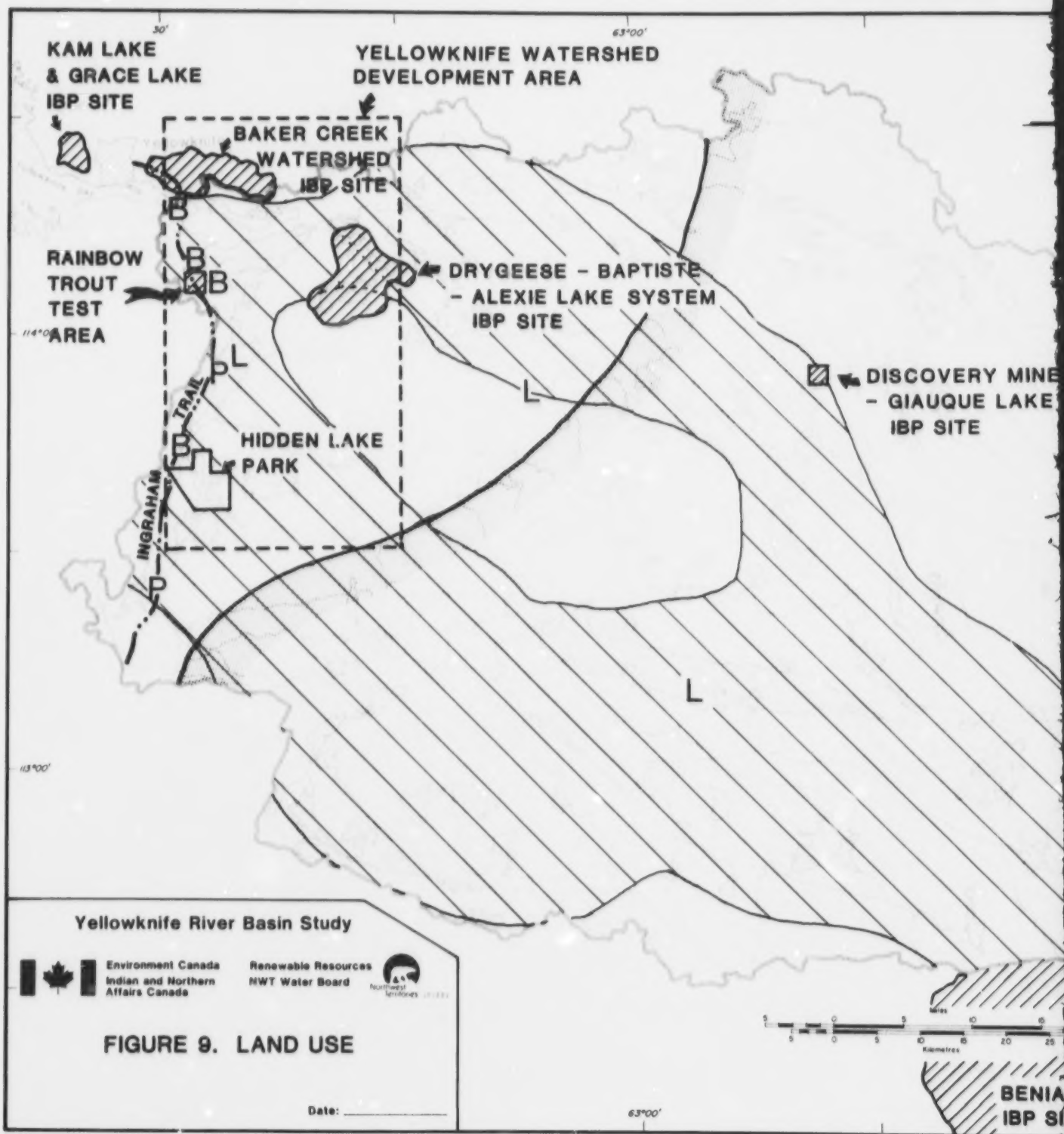
- Gordon Lake (63° 53'N, 113° 52'W)
- accommodates 12
- June-August
- boats, guides, freezers, etc.
- \$140 per day and up in 1987
- hosted 60-80 people in 1987
- 65% of guests were from the north

Yellowknife Lodge

- between Duncan and Graham lakes (62° 53'N, 113° 52'W)
- accommodates 12
- June to September
- boats, guides, freezers, plumbing, etc.
- \$450 per week, all-inclusive from Yellowknife
- hosted 30 guests in 1987, 4 for full weeks and 26 for weekends.

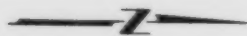
Prelude Lake Lodge

- on Prelude Lake on the Ingraham Trail
- accommodates 15
- May 15 to September 30
- boats, guides, freezer, store
- banquet and conference rooms



30'

64°00'



LEGEND

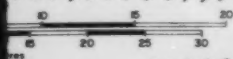
L - Lodge

B - Boat Pullout

P - Community Park

- Hunting and Trapping Areas¹ 114°00'- Bathurst Caribou Range¹VERY MINE
QUE LAKE
SITE

113°00'

BENIAH LAKE
IBP SITE¹ from Land Use Map Series, 1975

64°00'

3.2.4 Community Parks:

Prelude Lake - 28 campsites, 15 picnic tables

Reid Lake - 28 campsites, large day use area

Yellowknife River - boat launch, day use area

Madeline Lake - boat launch, picnic area

Pontoon Lake - day use area

Cameron Falls - hiking trails, scenic site.

A visit to these spectacular falls is an ideal day trip out of Yellowknife, especially when the Cameron River is at high stage. A short, 15 minute hike off the Ingraham Trail, it should be on the must-see list of any summertime tourist.

Powder Point - boat launch

Prosperous Lake - boat launch

3.2.5 Territorial Parks:

The Hidden Lake region has been proposed as a territorial park.

Figure 9 identifies the location of facilities listed in the previous sections.

3.2.6 International Biological Program (IBP) Sites:

The IBP is a cooperative program between 58 countries, including Canada. The objective of the Canadian part of the program is to locate examples of major ecosystems in Canada and to work toward their statutory protection as ecological reserves for the purpose of scientific research. An area recommended as an IBP site has no legal basis for protection until it receives legal status as an ecological reserve. Four sites in the Yellowknife region have been catalogued as potential IBP sites. They were selected in order to study areas once disturbed or still being disturbed by man's activities. All sites are representative of the northwestern transition zone of the Boreal Forest. Two of these sites are in the basin; one at the abandoned Discovery Mine on Giauque Lake and the second in the Drygeese-Baptiste-Alexie lakes system to the northeast from Prosperous Lake. The Discovery site was identified to study plant succession after disturbance and the second was suggested as a control area with little or no human impact to date. Both DIAND and DOE have sought to designate the second site as a research preserve.

3.2.7 Ingraham Trail:

Ingraham Trail is an all-weather road running east from Yellowknife along the southern boundary of the basin, past Prosperous and Prelude lakes and along the Cameron River. The road was originally conceived as a resource road and in fact, the winter road carries on from the terminus

of the Ingraham Trail to the Echo Bay property on Contwoyto Lake in the barrenlands. The road, however, is equally important for its access to recreational lakes and fairly extensive cottage development has occurred on the more accessible ones. Recreational use of the trail is not limited to summer; during the winter it is used for access to areas which offer snowshoeing, cross-country skiing, ice fishing and winter camping. Caribou hunters also utilize the trail and the winter road beyond for access to the wintering grounds of the Bathurst caribou herd. Increased emphasis on tourism in the NWT should make the trail of increasing recreational importance.

In the mid 1980's the GNWT Department of Economic Development and Tourism contracted a study of the Ingraham Trail and its adjacent land area, known as the Ingraham Trail Corridor (EDA Collaborative Inc., 1985). Objectives of the study were to inventory the existing recreational development of the corridor and to assess the area's tourist potential. The study also provided an overall strategy for developing the corridor's recreational assets. Many elements of this plan have since been implemented. Of the 12 sites identified in the plan, 11 utilize the waters of the Yellowknife or Cameron rivers. Study recommendations for enhancing the recreational potential of the area are summarized in Table 2.

table 2

	Trail Upgrade	Gravel Road	Upgrade Campground	Upgrade Day Use Area	Picnic Tables	Fire Pit	Boat Launch Upgrade	New Dock	Parking/Site Development	Trailhead Parking	Improvement	Trail Upgrading	Gravel	Surface	Drainage Improvements	Markers	Garbage	Management Zone Coordination	Guidelines / Future Study	Road Signs	Interpretive Signs
Giant Mine Site	●																			●	●
Yellowknife Bridge Crossing	●																			●	●
..south: boat launch & day use			○	●	●	●	○		●											●	●
..north: facilities					●	○												●		●	●
..gateway																				○	
Prosperous Lake	●							○	●											●	●
Madeline Lake	●							●												●	●
Big Hill Lake	●									●	●	●	●	●	●	●	○			●	●
Pontoon Lake	●		○	○	○		●			●	●	●	●	●	●	●				●	●
Prelude Lake Park	●									○								●		●	●
..campground			○															●		●	●
..day uses			○	○	○															●	●
..boat launch/marine							●	●	●	●										●	●
..trails											○	○	○	○	○	○				○	●
Powder Point	●		○	○	○		○	●	●											●	●
Cameron Falls Trail	●									●	●	●	●	●	●	●				●	●
Cameron Bridge Crossing	●										●	●	●	●	●	●				●	●
..west: day uses, trail head to falls			●	●	●	●				●	●	●	●	●	●	●				●	●
..central: day uses			●	●	●	○				●	●	●	●	●	●	●				●	●
..east: day use of rapids, along road			●	●	●															●	●
..Sand Dune Landscape	●																	●		●	●
Reid Lake Park	●		○		○		●	●												●	○
Tibbitt Lake	●		○			○												●		●	●
Overall Sign Program																				●	●

Table 2. Ingraham Trail Land Use Recommendations

3.2.8 Hydroelectric Power:

Nerco Con Mines presently operates a small, one-turbine power plant with a rated capacity of 3.2 MW, at the outlet of Bluefish Lake, a hydroelectric power site originally surveyed by Hoover (1941). The power plant supplies the company's mine and refinery in Yellowknife and on occasion, supplements the power supply for the city of Yellowknife. A storage reservoir, Duncan Lake on the McCrae River, is used to supplement the low natural flows at the power plant in the winter months. The system has been in operation since the late 1930's and its operating logs have supplied the longest record of streamflow in the NWT.

Other potential hydroelectric sites in the basin were surveyed by the Dominion Water and Power Bureau in 1940's (Wood, 1941, 1948). Six potential sites, three on the Cameron River and three on the Yellowknife River, were identified. All potential sites identified on the Cameron River were judged to be too small to warrant the construction of power facilities. One viable site on the Yellowknife River above Quya Lake was rejected by the Bureau because of construction difficulties. Another site, at the outlet of Angle Lake had inadequate power potential. The third site, above Rocky Lake, was recognized as the best untapped site in the basin and worthy of further investigation. At that time, the power potential of the site was rated at 2.4 MW. The three Yellowknife River sites are shown in Figure 8.

3.2.9 Fishing:

Sport fishing in the basin is based on road access, tourist lodges and increasingly, on fly-in fishing. There were approximately 6000 sport-fishing licences sold in the Yellowknife area in 1987. Not all of these fishermen used their licences in the basin, so a precise estimate of basin use for sport fishing is unknown as are statistics on numbers of fish caught. Principal species caught are lake trout, whitefish, walleye, grayling and pike. Winter ice-fishing is common in late winter-early spring along the winter road to Lupin and on numerous lakes near Yellowknife. There is also a small domestic fishery by residents of Yellowknife and Detah for food, for both humans and dogs.

Although there are no commercial fisheries presently operating in the Yellowknife basin, a number of lakes were fished for lake trout and whitefish historically. Johnstone and Pickerel lakes supported a walleye fishery; the former at one time had an annual commercial quota of 12,000 lbs. Duncan Lake was fished commercially for lake trout and whitefish with an established annual quota of 44,000 lbs.

Resource Development Division of the GNWT Department of Renewable Resources is planning to stock a number of small lakes near Madeline Lake with rainbow trout and arctic char. This experimental program is being considered only for small lakes with no connection to others in the

basin. The program is designed to fill a need for an enhanced sport fishery close to existing roads.

Some information is available on fish migration routes and spawning sites in the basin. In the spring and summer walleye, northern pike and arctic grayling migrate upstream along the Yellowknife River. These species use the mainstem of the river and its tributaries for spawning. In the fall, lake whitefish and cisco also migrate upstream along the Yellowknife River and probably spawn near Tartan Rapids. Arctic grayling, lake whitefish and lake trout also spawn below the power house at the inlet of the Yellowknife River to Prosperous Lake.

The Cameron River serves as a migration route and spawning area for arctic grayling. In the upper reaches of the basin, on the mainstem of the Yellowknife River, the stretches of channel which link Lower Carp Lake, Upper Carp Lake and Reindeer Lake serve as spawning grounds for arctic grayling in early spring.

3.2.10 Hunting and Trapping:

Native hunters and trappers from three communities, Yellowknife-Detah, Rae-Edzo and Snare Lake, use the basin for hunting and trapping. Caribou is the game most frequently hunted. The annual hunt begins in the late fall and carries on through the winter. Trapping is a winter activity when furs are in prime condition. Areas frequented by hunters and trappers include the mainstem of the Yellowknife River north of Quytá

Lake and west from Duncan Lake, the area east of Rocky and Fishing lakes, and the area to the east from Orkney and Grizzle Bear lakes. The most heavily hunted areas are in the southern part of the basin, along the Ingraham Trail and northwards to Gordon Lake on the winter road to Lupin. Hunting and trapping areas of interest are shown in Figure 9 as defined in the Land Use Map Series (EMR, DIAND, DOE, 1975).

Hunting in the basin is quite extensive, especially during the winter months when access is relatively easy by ice road or snow machine. During the 1985-86 season over 1650 general hunting licences were issued from Yellowknife as well as 2500 small game tags. Following is a list of the number of tags sold in Yellowknife in 1985-86:

Caribou -	1,615
Wolf -	135
Moose -	588
Bear -	238
Wolverine -	18

As with fishing licences, these numbers don't necessarily reflect the number of people who hunt in the basin, but they are likely a close estimate.

Hunting use is dependent on the availability of game, especially of caribou. In this respect, 1987 was an interesting year as the caribou occasionally wandered into the city. Along the

Ingraham Trail, many caribou were taken as they crossed the road. Usually hunters have to go as far as Gordon Lake to hunt in the winter and the easy access to caribou in 1987 ensured a large harvest of animals. Earlier big-harvest years for caribou were in the period 1981 to 1984 when large concentrations of animals wintered in the Gordon Lake region. The major kills of those years resulted in the establishment of the Gordon Lake control zone and the operation of checkpoints at the south end of Gordon Lake in the hunting season. The greater accessibility of caribou along the Ingraham Trail in 1987 resulted in the prohibition of hunting in a 2 km-wide corridor along the trail.

Caribou and moose continue to be an important country food for the native residents in Yellowknife and Detah who follow the seasonal movement of game throughout the basin. Residents of Snare Lake travel through the upper portion of the basin on their way to traditional hunting and trapping grounds in the Courageous Lake area.

There were no registered traplines in the basin in 1987. Generally, trappers tend not to register their lines because the basin is not heavily trapped and therefore there is little competition for fur resources in the region. It is estimated that there were approximately 20 to 30 trappers active in 1987. Marten, lynx, fox, mink and wolf are commonly taken. Total value of trapping in the basin is quite small, probably in the order of \$20-30 thousand dollars.

Photo page 3



Photo 5: The mouth of the Yellowknife River in Fall, looking East. Note the Ingraham Trail and hydro power line in centre, boat launch on far right of bridge, GNWT storage site on far left of bridge, and old mineral exploration cutlines on far extreme left of photo. The City of Yellowknife draws its water supply from the river upstream of the bridge.



Photo 6: Environment Canada technicians preparing to take bottom sediment samples at Upper Carp Lake during the 1987 basin reconnaissance program.

3.2.11 Wildlife Range:

The Bathurst herd of barren ground caribou range throughout the basin. Most parts of the basin, at one time or another, are included in their migration route. In early spring the herd moves north and east to calving grounds in the barrens, and in late summer and fall it migrates south and west into the basin. The area of the Nicholson River basin between Duncan, Thistlethwaite, Smoky, and Gordon lakes as well as the upper reaches of the Surprise River basin between Sharples and Prang lakes are extensively used winter ranges. Other parts of the basin frequently used by over-wintering caribou lie north from Bluefish Lake along the mainstem of the Yellowknife River. Wintering ranges are shown in Figure 9.

Mid-winter reaches of open water at rapids are prime habitat for otter. On the Yellowknife River the reach from Fishing to Rocky lakes remains open. Similar reaches are found on the Cameron River east from Gordon Lake and on the Gordon River between the lake and its confluence with the Cameron.

Many wolf dens are found in the region east from Orkney and Grizzle Bear lakes and some suitable moose habitat is located in the southern parts of the basin in the vicinity of Prosperous, Reid and Hidden lakes.

photo page 4



Photo 7: Gathering water quality samples at a site on the upper Yellowknife River during the 1987 basin reconnaissance program.



Photo 8: Installation of a water level recorder in a California style shelter with a perforated steel pipe stilling well at WSC station 07SB014, Prosperous Lake near McMeekan Bay, Spring, 1987.

4.0 **YELLOWKNIFE BASIN WATER RESOURCES:**

Previous sections have created the context for a more complete description of basin water resources. They illustrate some of the linkages between a basin's or a region's surface water resource and its physiography, geology, climate, vegetation and land use. This section reviews the available water resources data in detail.

4.1 Data Sources:

Historic water resource data which are available within the basin are summarized in Table 3. Additional water resource information was collected for this study in reconnaissance surveys made in the summer of 1987. Locations for existing stations operated by IWD and the reconnaissance sites are shown in Figure 10.

There are also some miscellaneous, historic data for water quality and sediment available from Environmental Protection Service (EPS) and from Water Resources Division of Indian and Northern Affairs Canada (INAC). These data were included in reports (Moore et al, 1978; Hale et al, unpub., 1979) to assess impacts of the abandoned Discovery Mine site and its environs on Giauque Lake, and in impact assessments of cottage development on Prosperous Lake and others along the Ingraham Trail.

4.2 Water Quality Data Analysis:

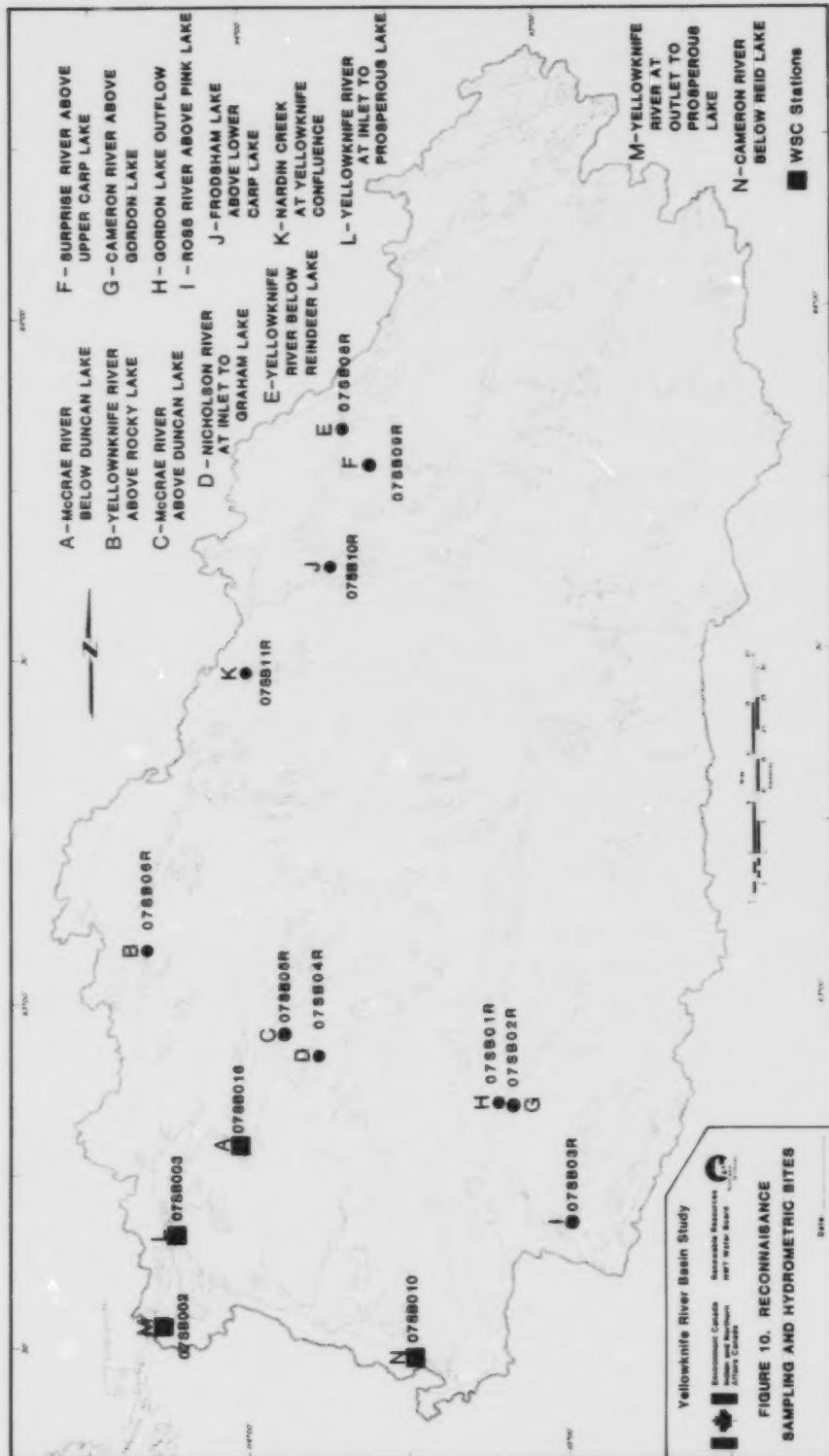
IWD Water Quality Branch data derive from monitoring programs on Cameron River below Reid Lake and on Yellowknife River above Yellowknife Bay. Reconnaissance data were also collected at a number of

Table 3

SITE OF INFORMATION	SITE ID	CHRONOLOGY	SITE TYPE
Water Quality Branch - Environment Canada			
Cameron River below Reid Lake	00NW07SB0011	May 1984 →	active station
Basin Reconnaissance	00NW07SB	1987 →	various sites
Yellowknife River above Yellowknife Bay	00NW07SB0001	1969; 72; Aug 86 →	active station
Water Resources Branch - Environment Canada			
Cameron River below Reid Lake	07SB010	1975 →	active station
Cameron River near the mouth	07SB004	1939 only	seasonal data
Duncan Lake near Yellowknife	07SB012	1975-88 (July)	manual gauge (Con Nerco)
Duncan Lake near Yellowknife	07SB012	July 1988 →	active station (Con Nerco)
Yellowknife River at outlet to Prosperous Lake	07SB002	1937-40; May 1987 →	active station
Yellowknife River Power Diversion, Site Y2	07SB006	1941-57	Con Nerco station
Yellowknife River at inlet to Prosperous Lake	07SB003	1939-40; 41-70; 72-88	Con Nerco power plant data
Yellowknife River at inlet to Prosperous Lake	07SB003	April 1988 →	active station
Yellowknife River (Bluefish Outlet)	07SB005	1941-57	Con Nerco data
Bluefish Lake near Yellowknife	07SB015	July 1988 →	active station
McCrae River below Duncan Lake	07SB016	July 1988 →	various data
Prosperous Lake (McMeekan Bay)	07SB014	May 1987 →	active station
Water Planning and Management Branch - Environment Canada			
Basin Reconnaissance	07SB	1987	various sites
Water Resources Division - Indian and Northern Affairs Canada			
Giaugue Lake at Discovery Mine	07SB	1978	study: Hg and Zn
Environmental Protection Service - Environment Canada			
Giaugue Lake below Discovery Mine	07SB	1978	10 sites on lake

Table 3. Yellowknife River Water Resource Data

figure 10



locations within the basin in 1987. The database is summarized in Table 4. There has been no analysis done for pesticides or other organic pollutants, which many researchers today consider to be a global threat to good water quality because of their long-range dissemination by means of high altitude winds.

4.2.1 Cameron River below Reid Lake:

Water quality sampling began at this site in May, 1984 and the twenty-three sample results obtained are used in this analysis.

Table 4 lists the parameters for which analysis was done, the parameter detection limits, the range and the mean of the sample data. Very low values are evident, especially for metals. Of the 15 metals analyzed, only copper, zinc and arsenic show a quantifiable value for each sample and even for these parameters, levels are close to detection limits. For example, the arsenic data show a range of concentration from 0.0001 to 0.0004 mg/L; the detection level is 0.0001 mg/L, and 10 of 23 samples were at 0.0001 mg/L concentration. Maximum allowable concentration in the Canadian Drinking Water Guidelines (1987) is 0.05 mg/L.

Physical parameters such as pH are also of interest. Although the basin is fully in the Canadian Shield, pH values at this site are slightly alkaline. Geologic remnants of basic rocks of Precambrian sediments and effects of the Laurentide glaciation are the likely explanation. These waters are not highly buffered, however,

table 4

PARAMETER	TYPE	BLANK	DETECT LIMITS	MAXIMUM ALLOWABLE CONCENTRATION*	MAX	MIN or <	MEAN
pH	PHYSICAL	5.87		6.5-8.5	7.9	6.8	7.42174
Spec. Cond.	PHYSICAL	1.1			84	56	67.1739
Turbidity JTU	PHYSICAL	0.28		5	1.6	0.3	0.5913
Temp. deg. C	PHYSICAL	25			21.1	-1	
Colour	PHYSICAL		<5	15	20	5	
Resid. non-fil	PHYSICAL	2	<1		2	1	
N - diss. as N	NUTRIENT	0.02			0.38	0.18	0.25261
C - diss. organic	NUTRIENT	0.2			7.3	5.7	6.50435
N - particulate	NUTRIENT	0.02			0.05	0.01	0.03348
C - organic	NUTRIENT	0.09			0.39	0.1	0.24739
P - total diss.	NUTRIENT	0.007	<0.003		0.027	0.003	
N - diss. NO ₂ /NO ₃	NUTRIENT		<0.01	10	0	0	
Alkalinity - CaCO ₃	CALCULATED		<0.1		31.7	20.7	24.9913
Alkalinity - phenol	CALCULATED	0	0	2 ug/l	0	0	
Ca - dissolved	CALCULATED	0.2			10.1	5.9	7.30435
Mg - dissolved	CALCULATED		<0.1		2.8	1.8	2.16522
F - dissolved	CALCULATED		<0.01	1.5	0.1	0.01	0.09304
K - dissolved	CALCULATED	0.06			1.3	0.9	1.06957
Na - dissolved	CALCULATED		<0.2		2.5	1.6	2.03913
Cl - dissolved	CALCULATED		<0.1	250	2.8	1.6	2.10909
Si - mac. as SiO ₂	CALCULATED		<0.02		1	0.35	0.5113
Sulfate - dissolved	CALCULATED	0.3		500	7	2.1	3.44348
Carbonate	CALCULATED	0			0	0	
Bicarbonate	CALCULATED	0.1			39	25	30
Hydroxide	CALCULATED	0			0	0	
Hardness as CaCO ₃	CALCULATED	0.9			36.7	22.1	26.7
Non-CO ₃ Hardness	CALCULATED	0.8			5	0	2.08
TDS	CALCULATED	1		500	44	28	33
Free CO ₂	CALCULATED	0.01			3.1	0.4	1.565
Lang. pH	CALCULATED	-5.498			-1	-2.6	-1.665
Ryzner pH	CALCULATED	19.48			12.4	10.1	10.89
Na %	CALCULATED	30.6			14.4	12	13.43
Total Org. C	CALCULATED	0.29			7.7	6	6.73889
Nitrogen - total N	CALCULATED	0.04			0.41	0.22	0.28609
P - particulate P	CALCULATED		<0.006		0.153	0.006	
Ammonia - not ionized	CALCULATED	0	0		0	0	
Cadmium - total	TOTAL METALS		<0.0001	5 ug/l	0.0004	0.0001	
Cobalt - total	TOTAL METALS			<0.0005	0.0001	0.0001	
Nickel - total	TOTAL METALS		<0.0005		0.002		
Copper - total	TOTAL METALS		<0.0005	1	0.007	0.0005	
Lead - total	TOTAL METALS		<0.0007	0.05			
Zinc - total	TOTAL METALS	0.0009		5	0.006	0.0007	
Barium - total	TOTAL METALS		<0.08	1			
Vanadium - total	TOTAL METALS		<0.005				
Iron - extractable	TOTAL METALS	0.021		0.3	0.11	0.01	
Mn - extractable	TOTAL METALS		<0.002	0.05	0.01	0.002	
Hg - total ug/l	TOTAL METALS	NS	0.02ug/l	1 ug/l	0	0	
Arsenic - dissolved	TOTAL METALS	0.0001		0.05	0.0004	0.0001	0.00024
Selenium - dissolved	TOTAL METALS			0.01	0.0004	0.0001	6.1E-05
Boron - dissolved	TOTAL METALS			5	0.04	0.02	0.02526
Cyanide	TOTAL METALS			0.2	0.002	0.001	0.00142

* From GUIDELINES FOR CANADIAN DRINKING WATER QUALITY (1987). Units in mg/l except where noted.

Table 4. Water Quality Data Summary - Cameron River Below Reid Lake.

based on the alkalinity and hardness results.

Some parameters show a fairly consistent seasonal trend. Graphical analysis, Figure 11, for specific conductivity as measured in the laboratory illustrates this association. Numerical analysis suggests that it is possible to predict conductivity at Cameron River station based on the time of year when the latter variable is defined in a 'water year' beginning May 20. Less significant correlations are also evident in the relationship of water flow to concentrations of sodium, chloride, potassium and calcium ions, and to conductivity. One possible explanation for these correlations might be the variable sources for Cameron River flows; the spring runoff source is largely from snowmelt and the late-summer and winter flows have experienced longer periods of interaction with the basin land surface. Table 5 summarizes the significant correlations from the numerical analyses conducted.

VARIABLES	CORRELATION COEFFICIENT (r)
Na - K	0.966
Na - Conductivity	0.941
K - Conductivity	0.910
Ca - Conductivity	0.890
Ca - Na	0.889
Day - Conductivity	0.887
Ca - K	0.886
Day - K	0.778
Day - Ca	0.750

Table 5. Correlation coefficients for nine key parameters (all correlations significant)

Figure 11

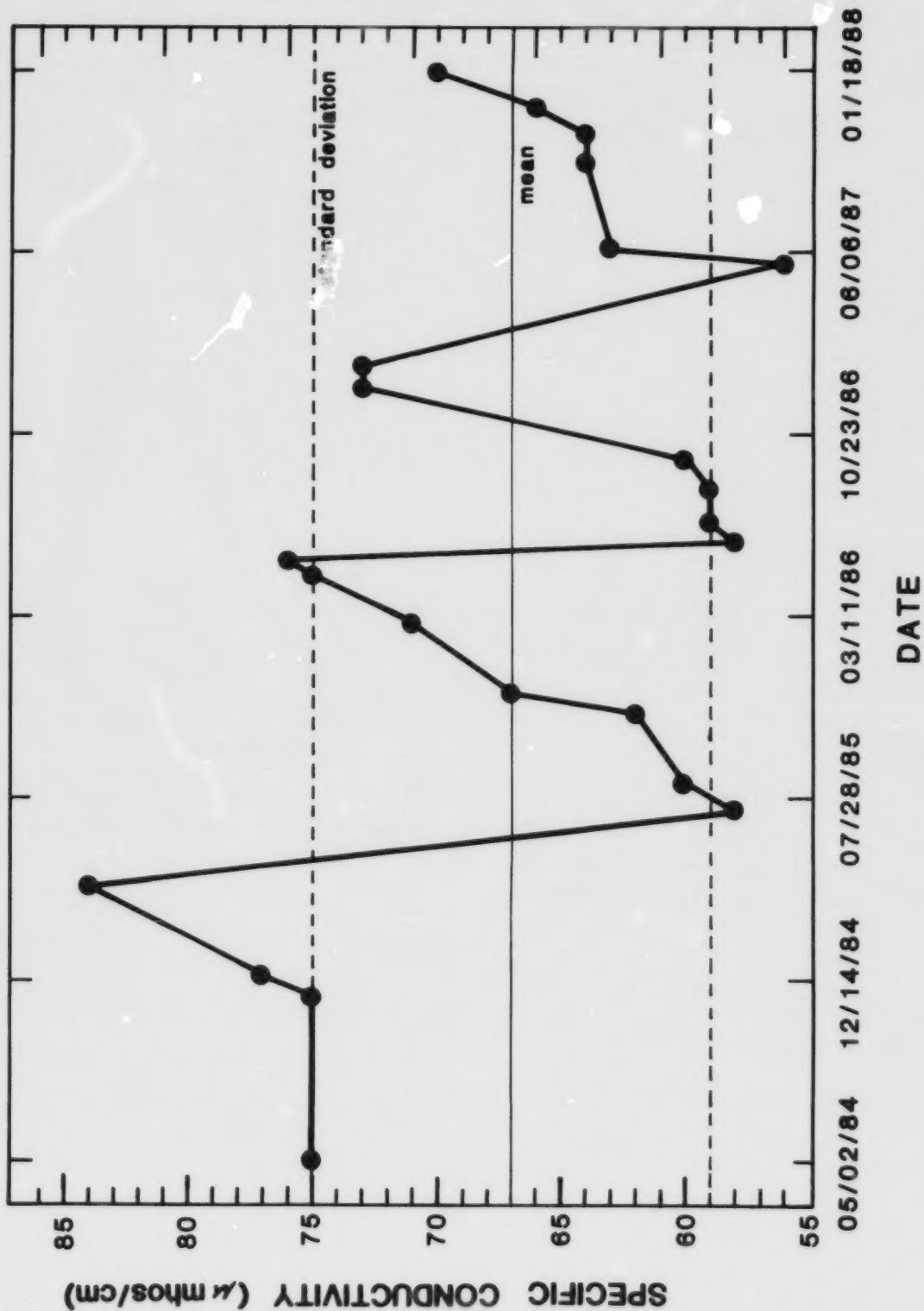


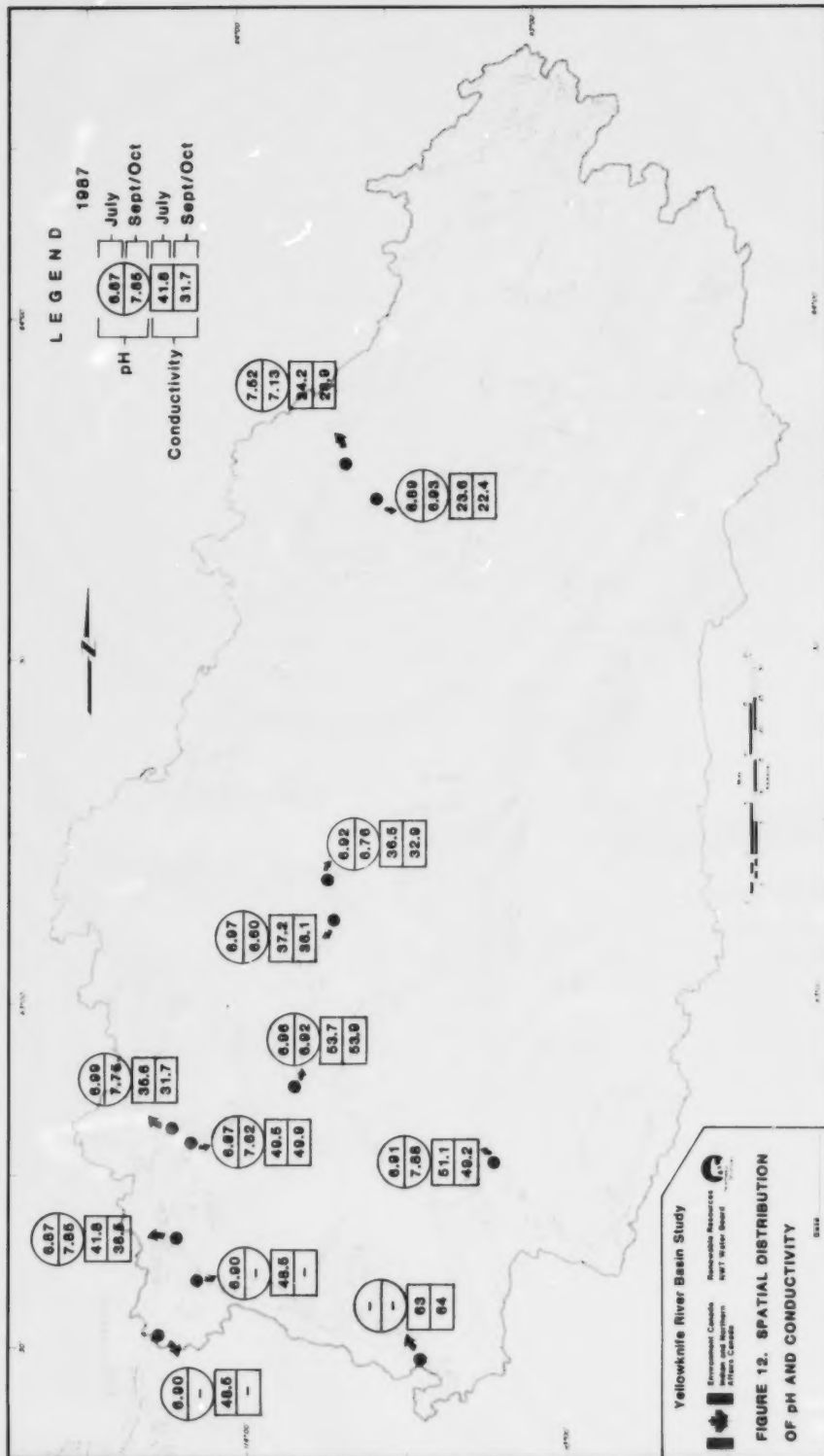
FIGURE 11. SEASONAL TREND IN SPECIFIC CONDUCTIVITY

4.2.2 Spatial Distribution of Water Quality Indicators in the Basin:

July and September surveys were made in 1987 to investigate spatial differences in basin water quality. The results show that Yellowknife River basin water quality parameters were much more uniformly distributed in space than was the case in the Coppermine River basin to the north (Wedel, et.al., 1988). In this earlier study, variations in pH and conductivity were thought to be influenced by geology. The Yellowknife basin is underlain by rocks of Archean age and many of these rocks are of sedimentary origin and include carbonates. Carbonates in flowing fresh water tend to generate moderately basic solutions which makes them good buffering agents to counteract the effects of acid precipitation. The data for pH are presented in Figure 12. In July, when snowmelt waters still dominate the flow regime, the basin surface waters are almost entirely on the acidic side of pH 7.0. The only exception is in the very upper end of the Yellowknife mainstem. For the remainder of the basin, July pH was remarkably uniform. The ten remaining samples had a mean pH of 6.93 and the scatter about that mean was ± 0.06 pH units.

Spatial distribution of pH was not so uniform in the fall of 1987, however. The September - October series of nine samples showed a range of values from pH 6.60 to 7.88, a scatter from mildly acidic waters to samples which were moderately basic. The trend from the slightly acidic

figure 12



snowmelt waters of early summer to the more basic groundwater contributions later in the year is evident in several sections of the basin. The large shift in pH, from 6.9 to 7.6, in the McCrae/Nicholson sub-basin from above to below Duncan Lake should be investigated further.

The distribution of specific conductivity values in the basin are also illustrated in Figure 12. They lie within a narrow range; from 22.4 μ mhos in the northern upper basin to 64 μ mhos at the southern extremity in the Cameron sub-basin. Conductivity data remained relatively unchanged from summer to fall in 1987, a year in which river flows in the basin were well below average and fairly uniform throughout the ice free months. River flows at Cameron River below Reid Lake station for the two periods of reconnaissance were 2.5 m^3/s in July and 1.8 m^3/s in late September and early October. This may have been a contributing factor in the explanation for the summer-fall uniformity in the conductivity data set. It is apparent though, that there is a spatial trend to the data set; conductivity increases from north to south, but the range of the data are small.

Similar results as the ones detailed here for conductivity, were obtained from spatial analysis for hardness (CaCO_3), bicarbonate, dissolved sulphate, silica as SiO_2 , and alkalinity as CaCO_3 . The Nicholson River sub-basin showed consistently higher values than did other sub-basins.

4.2.3 Metal Parameters:

A characteristic for this class of parameters, which are of great interest because of mining activity in the basin, is that they consistently hover around their respective detection limits. The numerical data are therefore of questionable reliability, since they are values obtained at the limits of laboratory detection equipment.

In total, the 1987 reconnaissance collected 25 samples. Twenty-three were used in this analysis. The metals data can be summarized as shown in Table 6. One hundred and thirty-three of

METAL/MINERAL	DETECTION LIMIT ⁽¹⁾	# SAMPLES WITH DATA	RANGE ⁽¹⁾
Cadmium	0.0001	12 of 23	<0.0001-0.0002
Cobalt	0.0005	2 of 23	<0.0005-0.0006
Nickel	0.0005	8 of 23	<0.0005-0.0014
Copper	0.0005	23 of 23	0.0005-0.0016
Lead	0.0007	1 of 23	<0.0007-0.0010
Barium	0.08	0 of 23	all < 0.08
Vanadium	0.0005	0 of 23	all < 0.0005
Iron (extractable)		22 of 23	0.007-0.132
Manganese (extractable)	0.002	16 of 23	<0.002-0.007
Mercury ⁽²⁾ (total µg/l)	0.02 µg/l	0 of 4	all < 0.02 µg/l
Arsenic (dissolved)		23 of 23	0.0001-0.0004
Selenium (dissolved)	0.0001	9 of 23	0.0001-0.0002
Boron (dissolved)	0.02	4 of 23	0.02-0.03
Cyanide	0.001	4 of 23	0.001-0.002
¹ All units in mg/l except otherwise noted			
² Hg analysis only for McCrae River above and below Giauque Lake			

Table 6. Metal Analysis Summary - 1987 Reconnaissance

303 metal values were above detection limits. Of these 133 measured values, 35 were at the detection limit. The data tables reiterate, in a numerical way, the conclusion that Yellowknife basin waters are among the most pure surface waters in Canada.

4.2.4 Giauque Lake - Discovery Mine Investigations:

Discovery Mine, closed since 1969, is located at the west end of Giauque Lake, Figure 8. Tailings disposal (Moore et al, 1978; Hale et al, 1979) occurred without appreciation for its impacts on the aquatic environment and heavy metal contamination of the lake from leaching and erosion resulted. The EPS and DIAND studies show that the lake sediments have been and continue to be contaminated by mercury. Samples of the water column in Giauque Lake and downstream lakes made in the period, April to September, 1978, showed that mercury was present at very low levels in the water column, most notably in June. These data could not be used, however, to identify Discovery Mine as the sole source of contamination; the control site selected, Maguire Lake, outside the catchment drainage system and therefore physically disconnected from the point source of contamination from the mine site, showed mercury levels of similar magnitude in June. The June water quality analysis for mercury is summarized in Table 7. The water quality samples made in August, October and December, with improved detection limits of 0.01 µg/L, did not show any detectable mercury in the water column anywhere in the study area.

table 7

STATION #	LOCATION	Hg [µg/l]	REMARKS
GLM-5T	Maguire Lake	0.49	Control Site (0.24 µg/l in July)
GLM-5M		0.26	
GLM-5B		0.18	
GLM-4T	above Giauque Lake	0.49	above Mine Effects
GLM-4B		< 0.10	
GLM-10T	Giauque Lake	< 0.10	100 m from tailings fan
GLM-10B		< 0.10	
GLM-9T	Giauque Lake	0.14	West end - inner basin
GLM-9M		3.30	
GLM-9B		0.18	
GLM-8T	Giauque Lake	< 0.10	Mid-lake ridge (0.25 µg/l in July)
GLM-8B		< 0.10	
GLM-7T	Giauque Lake	0.27	East end - outer basin
GLM-7M		0.25	
GLM-7B		0.75	
GLM-6T	Winter Lake	0.14	below tailings in Round Lake (0.33 µg/l in July)
GLM-6B		0.48	
GLM-3T	below Giauque Lake	< 0.10	between Giauque and Thistlethwaite Lake
GLM-3M		< 0.10	
GLM-3B		< 0.10	
GLM-2T	inlet Wagenitz Lake	< 0.10	July sample: 0.18
GLM-2B		0.21	July sample: 0.75
GLM-1T	outlet Wagenitz Lake	0.16	
GLM-1B		0.30	
T = TOP, M = MIDDLE, B = BOTTOM			

Table 7. Mercury Concentrations in Water Column, 1978 Giauque Lake

Mercury contamination was detected in all lake bed sediment samples obtained in the course of the study by Hale, et.al., (1979). The results, reproduced here as Table 8, raise some questions about regional background levels of mercury of 0.03 mg/kg as defined by Moore et.al., (1978). The data in Table 8 show that lake sediments in Maguire Lake, the control site, were found to be 0.23 mg/kg. Nevertheless, concentrations of mercury at GLM8 and GLM9 in Giauque Lake were eight and 21 times greater than Maguire Lake levels.

STATION	LOCATION DESCRIPTION	TOTAL MERCURY (mg/kg)
GLM1	Outlet of Wagenitz Lake	0.011
GLM2	Inlet to Wagenitz Lake	0.016
GLM4	Lake A	0.004
GLM5	Maguire Lake	0.23
GLM6	Winter Lake	0.005
GLM7	Middle of Outer Basin; Giauque Lake	0.20
GLM8	Ridge between Inner & Outer Basins; Giauque Lake	1.94
GLM9	Middle of Inner Basin; Giauque Lake	4.99

Table 8. Mercury in Giauque Lake Sediments, 1978

The significance of the water column and lake bed results considered together, is that the aquatic pathways of mercury in a water environment do not include the water column itself. This conclusion is in agreement with the findings of Gavis and Ferguson (1972) who stated that mercury is preferentially mobilized by living organisms rather than by solution in the water. Mercury

contamination thus appears in the food chain rather than in the water column. In Giauque Lake, ".....the levels of total mercury in lake trout (up to 12.3 mg/kg), northern pike (up to 4.8 mg/kg), and round whitefish (up to 2.64 mg/kg) exceed all recorded values in fish in the Northwest Territories, and are comparable to those in fish from some of the most highly polluted water bodies in Canada " (Hale, et.al., 1979, p.9). The waters of the Yellowknife River basin may be among the cleanest anywhere, but the sediments and fish of Giauque Lake are not.

4.3 Basin Streamflow Data Analysis:

The data available in the basin for streamflow and water levels are listed in Table 3. A total of ten stations in the basin are identified in the Water Resources Branch (1988) station index listing. Of these ten, seven are active stations, but only two, Cameron River below Reid Lake, 07SB010, and Yellowknife River at Inlet to Prosperous Lake, 07SB003, have flow data available for a significant time period. The Cameron River station records began in 1975 and the Yellowknife River records date from the beginning of operation of Nerco Con hydro-electric power plant below Bluefish Lake in 1939. The latter data set was contributed data by Cominco for the period, 1939 to July, 1981. These records were derived by means of hydraulic rating equations applicable to the generating unit and associated structures. In July of 1988, WSC installed a standard WSC gauging station below the power plant as a joint venture between Nerco Con, DIAND Water Resources Division, and WSC. Preliminary results have identified an approximate $6 \text{ m}^3/\text{s}$ disagreement

between hydraulic data and WSC data with the latter being the greater. This is not yet resolved. The data from this station are nevertheless the longest record of streamflow in the basin and in the region.

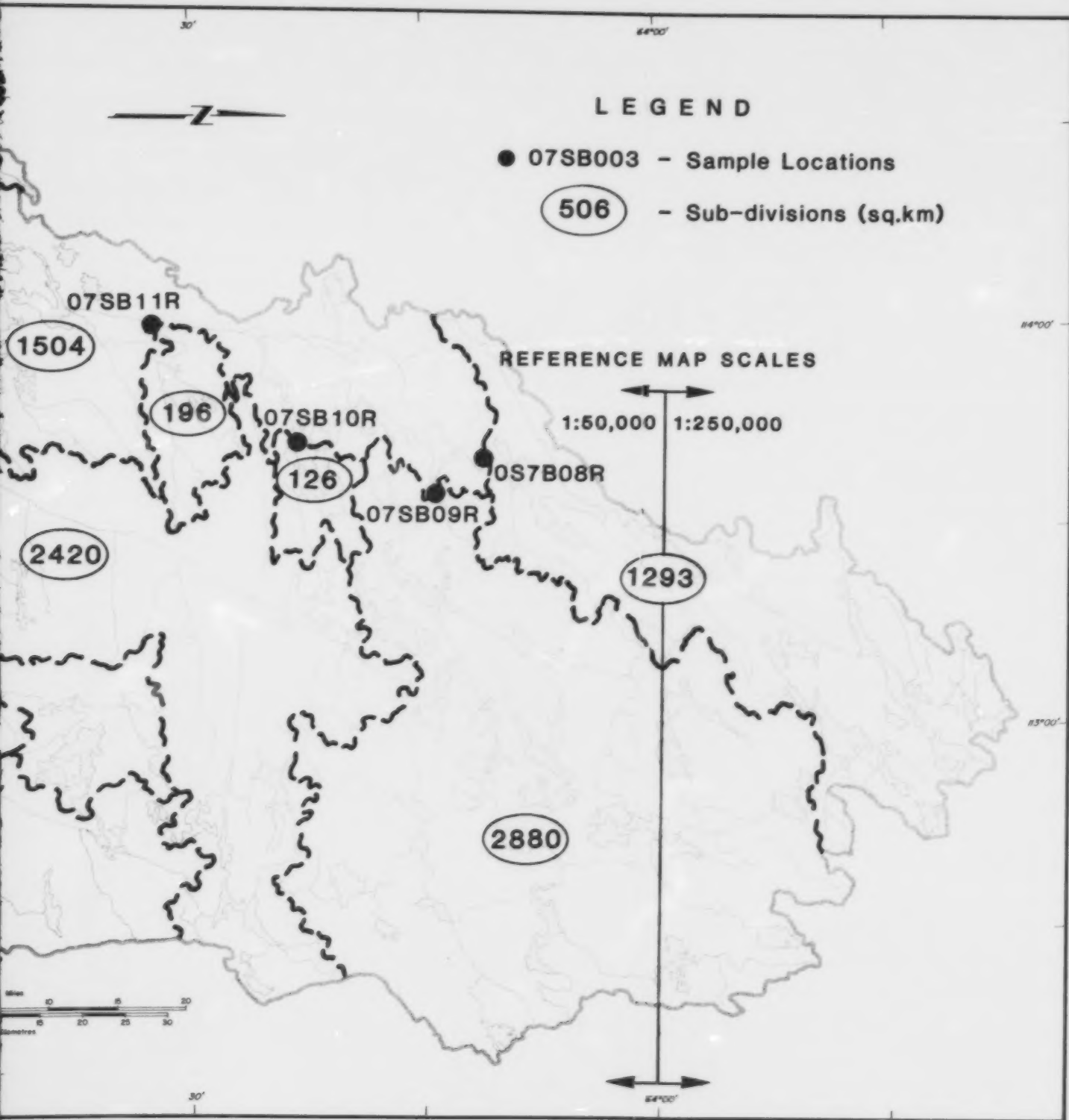
4.3.1 Drainage Areas:

The Water Survey of Canada routinely develops drainage areas which apply to each station. These are delineated on 1:250,000 maps sheets. For this study, it was necessary to prepare delineations for many sub-basins within the larger Yellowknife basin in order to relate flow data obtained in the reconnaissance to accurate drainage areas. An extensive new delineation for the basin was therefore done on 1:50,000 scale maps south of 64° N latitude. The sub-basins north of 64° N were delineated on 1:250,000 maps. Good agreement between drainages derived from 1:50,000 and from 1:250,000 maps can be inferred from the data for 07SB010, Cameron River below Reid Lake; the difference is just over 1%. For the total basin, the data in Table 9 show the difference to be 2.5%. Sub-basin areas within the larger Yellowknife basin are shown in Figure 13 and are listed in Table 9.

4.3.2 1987 Streamflow Data from Reconnaissance:

Two sets of streamflow data were acquired at selected reconnaissance sites in the Yellowknife basin in June and September of 1987. Flow data were obtained at those stations in Table 9 whose identifier number ends in 'R'.





STATION ID	GEOGRAPHIC LOCATION	AREA (km ²)
07SB03R*	Ross River above Pink Lake	165
07SB02R	Cameron River above Gordon Lake	1770
07SB01R	Gordon Lake Outflow	663
07SB010	Cameron River below Reid Lake	3590
07SB08R	Yellowknife River below Reindeer Lake	1290
07SB09R	Surprise River above Upper Carp Lake	2880
07SB10R	Frodsham Creek above Lower Carp Lake	126
07SB11R	Nardin Creek at Yellowknife Confluence	196
07SB06R	Yellowknife River above Rocky Lake	5990
07SB04R	Nicholson River at Inlet to Graham Lake	740
07SB05R	McCrae River above Duncan Lake	2420
07SB016	McCrae River below Duncan Lake	
07SB003	Yellowknife River at Prosperous Lake Inlet	11300 ²
07SB002	Yellowknife River at Prosperous Lake Outlet	15900 ³
* Station number ending in R is 1987 reconnaissance station. ¹ WSC drainage based on 1:250,000 map is 3630 km². ² WSC drainage based on 1:250,000 map. ³ WSC drainage based on 1:250,000 map is 16300 km².		

Table 9. Drainage Area Delineation for Basin Flow Stations

Analysis shows little spatial trend in runoff within the basin except for the higher runoff from the Surprise and Upper Yellowknife rivers which both originate in the barren lands. In June, 1987, the highest streamflow, expressed as litres per second per square kilometre (L/s/km²), was in the Surprise River at 2.16 L/s/km²; lowest at 0.67 L/s/km² in the McCrae River, immediately to the south of the Surprise basin. Differences in lake storage might explain some of the variation - the

assumption here being that the McCrae River, with fewer lakes, would have already been well past its spring peak flow period. The results of a basin snow survey, conducted by DIAND staff before the spring melt, do not assist in explaining the profound differences in flow for the two adjoining sub-basins.

A basin schematic, Figure 14, summarizes the sub-basin areas and the June - September reconnaissance results. Subjective comparisons of the fractions of total area with June and September measured flows strengthen the perception that a trend from south to north exists in streamflow volumes per unit area. For example, the Surprise River, 18.1% of the total Yellowknife basin area, produced 24.3% of the basin flow in June and 43.3% of the total flow in September. Conversely, the Upper Cameron River in the southeast portion of the basin contains 11.1% of the total area but generated only 8.2% and 3.6% of the total flow in June and September, respectively.

On a cautionary note, these data and their analysis can only be applied to 1987 which was a low-water year. Quite different results might have been obtained in 1986, when the Yellowknife River basin experienced record high water flows. It is also highly likely that the flows measured over five days in June, 1987 were obtained from different parts of a sub-basin's seasonal flow hydrograph. For example, the June excursion might have sampled the snowmelt flood wave at its peak

figure 14

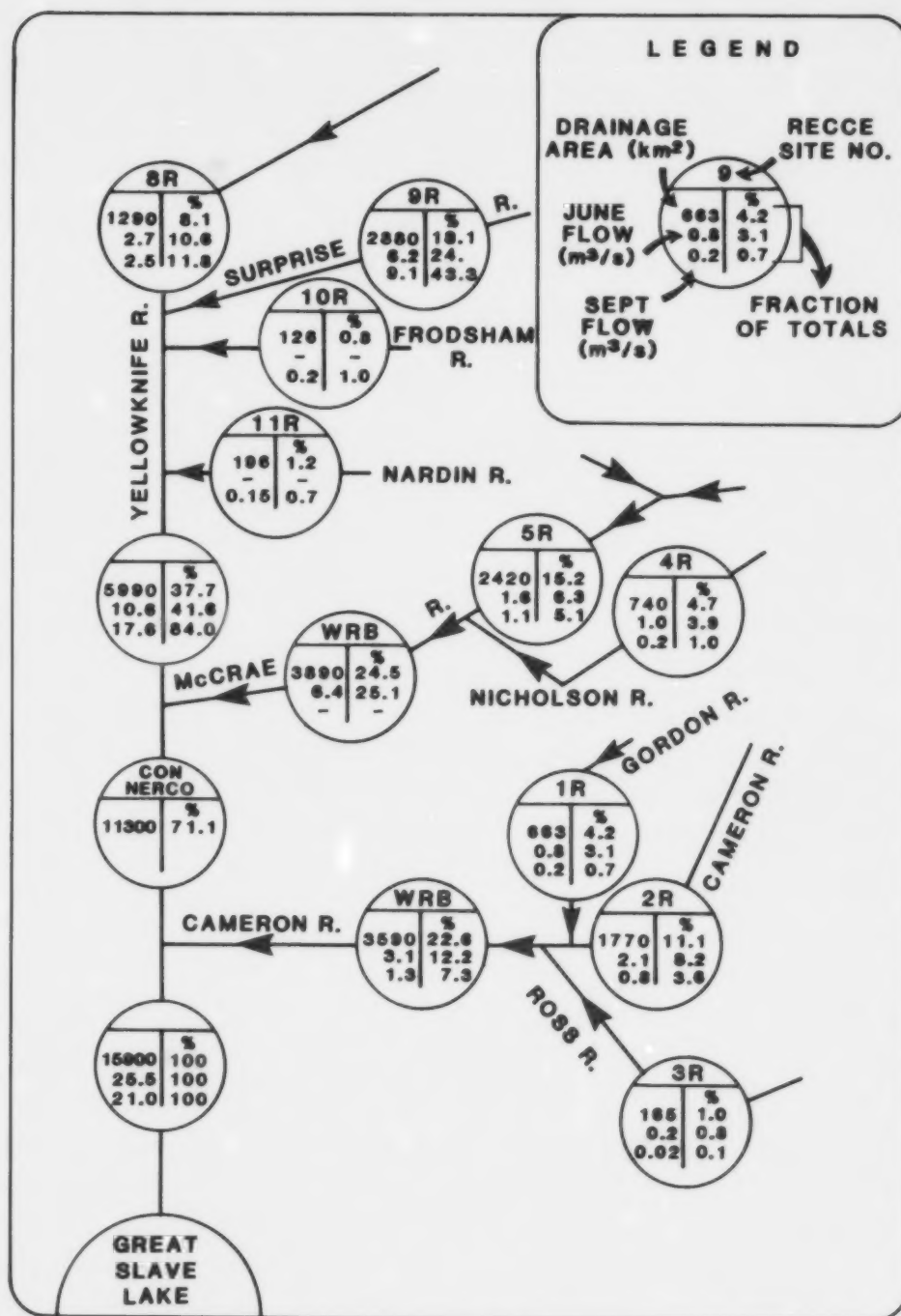


FIGURE 14. SPATIAL ANALYSIS OF 1987 RECONNAISSANCE FLOW DATA

on the Surprise River and have sampled the spring flood well past its peak on the Upper Cameron or Ross rivers. Differences in lake storage and basin size lend support to such theories. Details on stream behaviour must await a more intensive measurement program. The reconnaissance data succeeds in painting only a crude outline of streamflow relationships inside the Yellowknife basin.

4.3.3 Cameron River below Reid Lake, 07SB010:

Water Survey of Canada has collected hydrometric data at this site since 1975; see Appendix A for the station description. The data series is continuous from July 18, 1975 to the present. Historic data are available from Inland Waters Directorate district office in Yellowknife. The standard data set is supplemented by other information for water levels, hourly flow data and records of discharge measurements, available on request. Discharge measurement records provide information on water temperature and river cross-section water depths.

The WSC flow record is derived from a field data collection program which relates streamflow to water level. The relationship between the two is known as a rating curve. For 07SB010, the stage discharge rating consists of two parts; one for the low range below water level of 1.950 m, Figure 15, and one for the high flow range above 1.95 m, Figure 16. Two ratings are required because of hydraulic channel conditions at the station.

figure 15

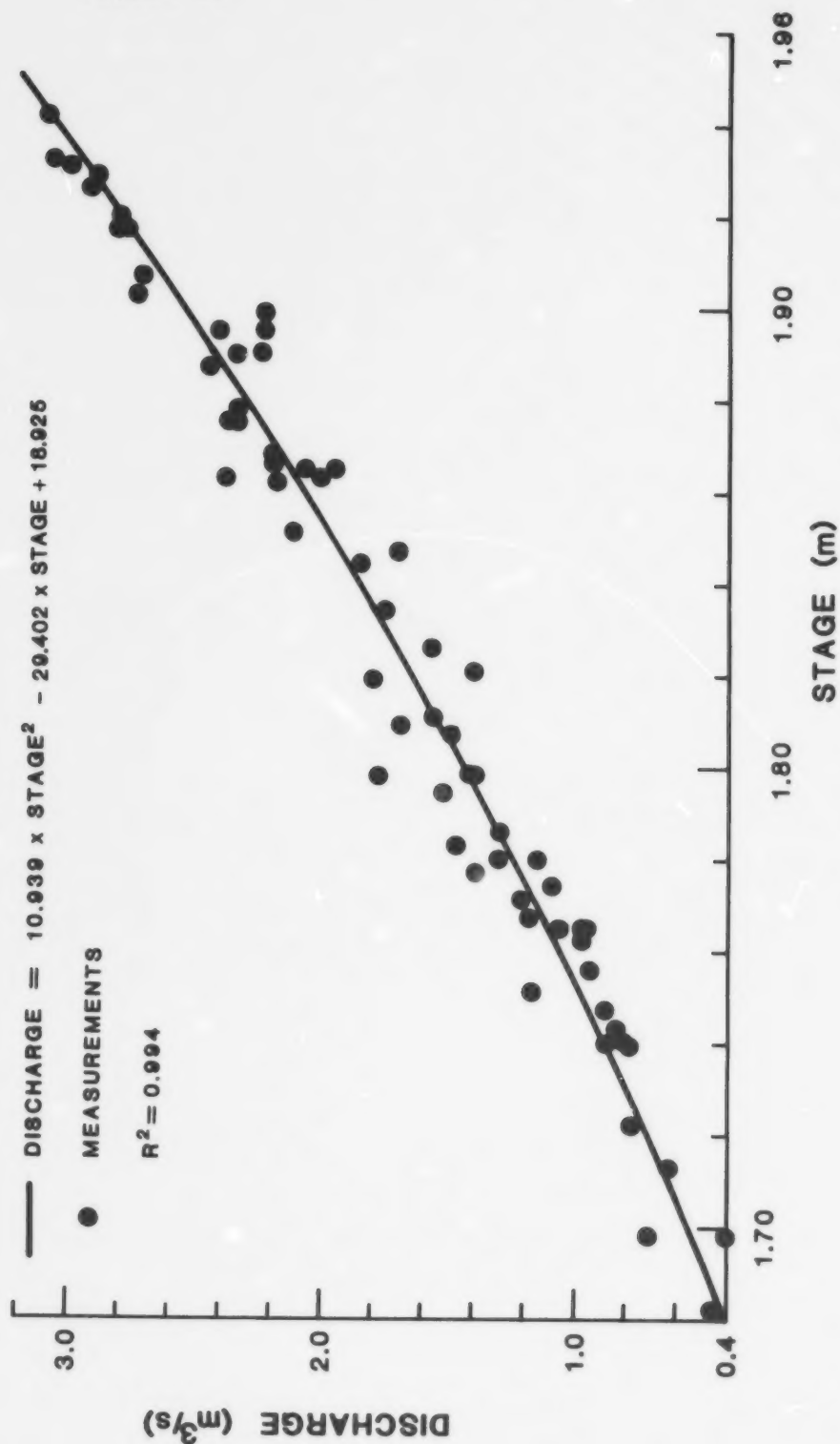


FIGURE 15. LOW-END RATING FOR CAMERON RIVER BELOW REID LAKE, 07SB010

figure 16

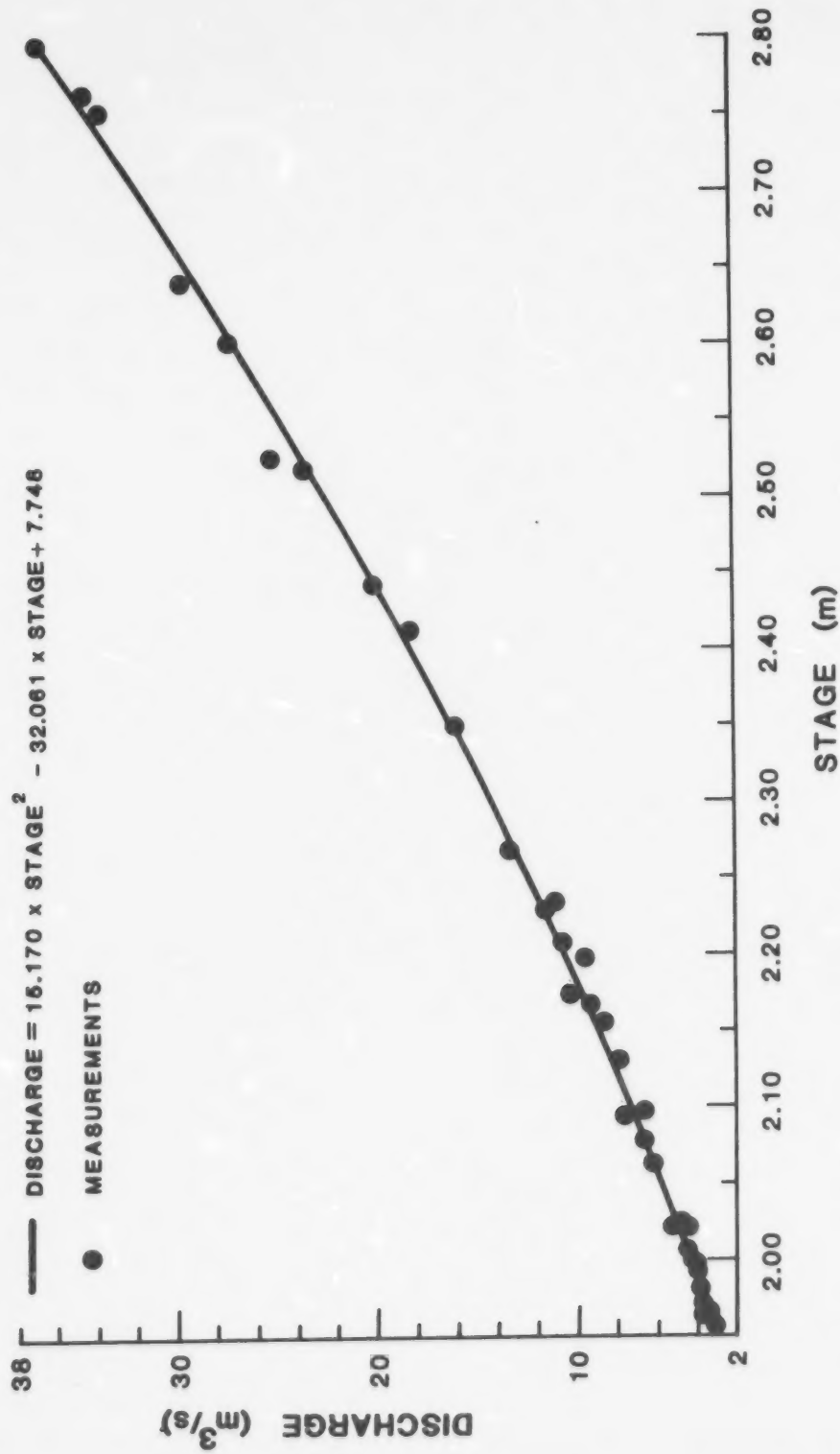


FIGURE 16. HIGH-END RATING FOR CAMERON RIVER BELOW REID LAKE. 07SB010

The scatter of data points about the line of regression for the low-flow rating, Figure 15, is from intermittent ice effect in winter on many of the measurements, from weeds in the summer period, and from uncertainty in water depth measurements because of a rough bottom in the measurement cross-section. Computation by WSC of the historic flow record has taken the departures from the mean curve into account by applying seasonal or periodic shifts to the relationship.

It is evident in Figure 16 that the high-end rating is significantly better than the low flow relationship. What little scatter is evident is attributed to measurement error introduced from suspension and positioning difficulties and also from the use of various cross-sections in high-flow conditions.

The total annual flow data show that discharges on an annual basis are highly variable. Annual totals are available for 12 years and are shown in the histogram in Figure 17 for the years 1976 to 1987, inclusive. Preliminary figures for 1988 indicate a return to high flows similar to the regime of 1985. Clearly, there is little persistence or carry-over from one year to the next in terms of total annual runoff.

Estimates of maxima of total annual flow from only 12 years of data can only be quite crude; the sample size is simply insufficient for good estimates. The results of such analysis, which follows, should therefore be treated with caution.

figure 17

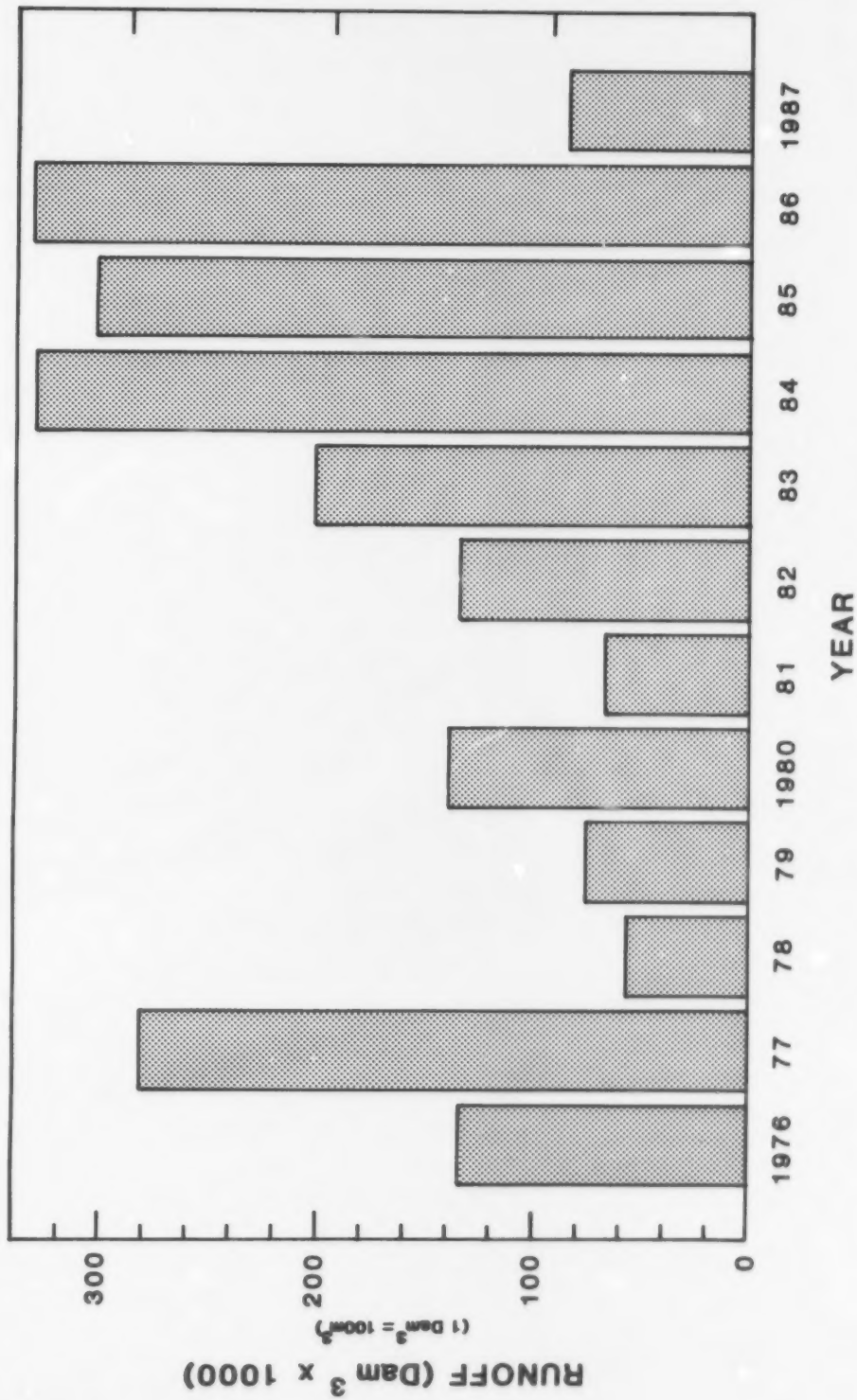


FIGURE 17. ANNUAL RUNOFF - CAMERON RIVER BELOW REID LAKE

Inspection of the data in Figure 17 shows that four annual totals are low, four are of medium size and four are high yield. Aitken and Westermann (1986) suggest that a 3-parameter log-normal distribution fits most data for floods in NWT rivers. Analysis of annual yield by this method suggests that an annual total flow of 430,000 dam³ has a probability of occurrence of 5%. The data in Figure 17 show that in three years out of 12 or 25% of the time, flow totals exceeded 300,000 dam³. Figure 17 also suggests that in four years out of 12 or 33% of the time, total annual yield is less than 100,000 dam³.

There are 13 annual floods documented in the existing WSC record for the period 1976 to 1988 inclusive, Figure 18. The best fit distribution as derived by the Wakeby distribution with software developed by Condie and Harvey (1984), indicates that floods with a 10-year and 20-year return period are 32.8 and 38.6 m³/s, respectively. There is great uncertainty about these predictions because of the short length of record.

4.3.4 Yellowknife River at Inlet to Prosperous Lake, 07SB003:

One of the longer flow data sets for the Northwest Territories exists for this flow station. The data in the historical record (IWD, 1988) begins in 1939 and continues through 1981. These data were contributed by Cominco Mines, which is now known as Nerco Con Mines. The published flows were derived from manual gauge

figure 18

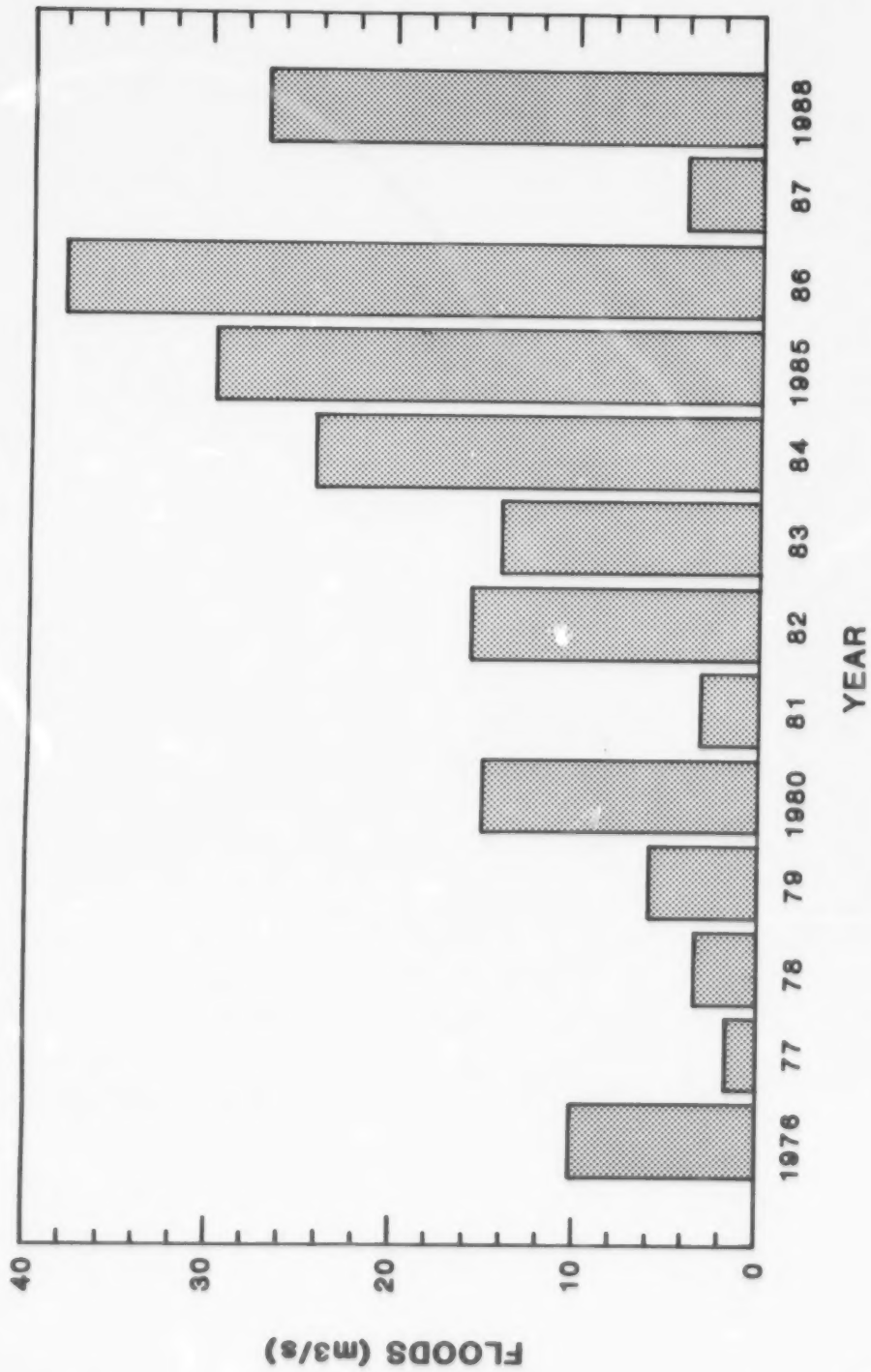


FIGURE 18. ANNUAL FLOODS FOR PERIOD OF RECORD - CAMERON RIVER

readings and hydraulic hydro plant ratings plus by-pass flows calculated from a weir rating. Beginning in 1984, the WSC undertook development of a tailrace rating which measured both the power plant discharges and the by-pass channel flows below the junction of the two; see station description in Appendix A. Water levels at the time of flow measurement were referenced to a Nerco Con benchmark at the power plant. As part of a three-party agreement between Nerco Con, DIAND and IWD, automated stream gauging equipment was installed at the site in 1988. Preliminary results show that the Nerco Con hydraulic plant and weir ratings are in disagreement with the rating curve developed by the WSC program. Further study to resolve the differences is on-going. Figure 19 illustrates the flow rating developed by WSC. It will be used to compute discharges for 1988 IWD publications. As can be noted from the figure, the rating needs further development below 20 and above 120 m^3/s .

The discrepancy between the Nerco Con hydraulic plant and by-pass ratings and the WSC rating is consistently in the order of 5 to 6 m^3/s , WSC data being larger. It is not yet possible to establish the applicability of this preliminary 1988 finding to the historical data set. If the disagreement is resolved in new studies, the following analysis might require adjustment.

Annual yield data are available for years of complete record. This encompasses the years 1941 to 1981 but excludes 1976 and 1977 which have

figure 19

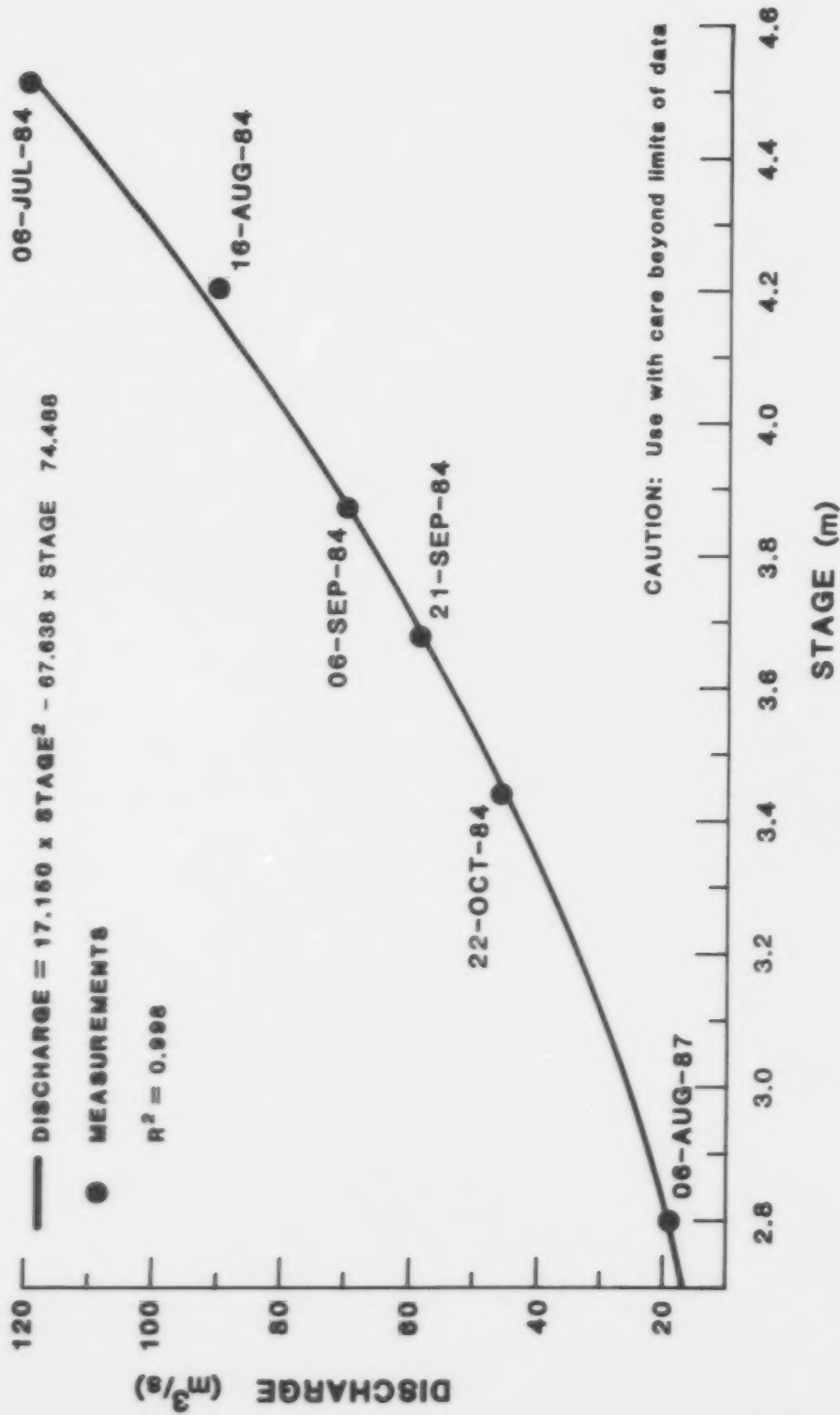


FIGURE 19. FLOW RATING - YELLOWKNIFE RIVER AT INLET TO PROSPEROUS LAKE

months with missing data. Complete data therefore is available for 38 years. Daily flows are not natural; the Duncan Lake storage reservoir on the McCrae River is utilized to augment the low flows of winter and early spring. The effect of this on annual yield is not thought to be highly significant. Storage release has the effect of shifting the release of some current year water into the next calendar year, but then, the previous year's water was also shifted to be released in the current year. Net effect therefore would depend upon how different one winter's release was to the next. A detailed management plan for the Yellowknife River basin might wish to address this question in greater detail. This analysis uses the data as published by IWD (1988), leaving the 5 - 6 m³/s discrepancy unresolved.

For the period, 1942 to 1981, except for 1976 and 77, the smallest annual yield was 499,000 dam³ in 1945; the largest was 1,520,000 dam³ in 1975. Average yield for 38 years was 893,000 dam³. Frequency distributions of annual yield were calculated according to Condie and Harvey (1984) using the Wakeby analysis, Figure 20, which most nearly approximated the distribution of sample data in the high end of the distributions. The values derived for 200 and 500 year return periods are considered to only crude estimates since they are extensions of data whose greatest return period from real sample data is only 38 years. It is unfortunate that the very high flow data of 1984, 85, 86 and 88 are not part of this data set.

figure 20

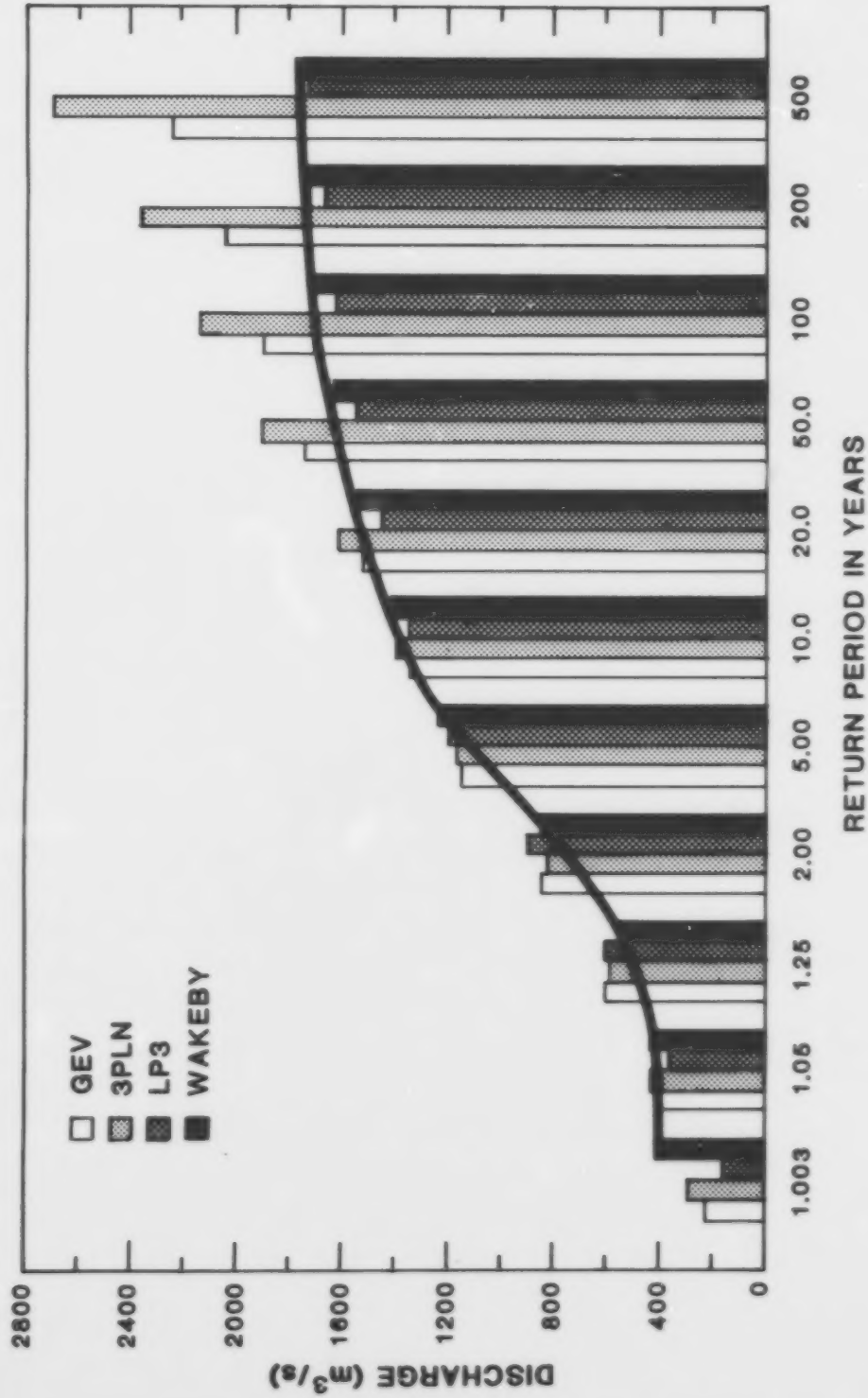


FIGURE 20. ANNUAL YIELD, 07SB003, FREQUENCY ANALYSIS

Inclusion of four extremely high flow years would have altered the high-end return period estimates significantly.

For the analysis of annual floods, estimates were made for the annual floods in 1976, 1977 and the years 1982 to 87 inclusive. The estimates were based on Nerco Con data, WSC flow measurements and flow data from the Cameron River station. Analysis for this total sample of 48 showed reasonably good agreement between the generalized extreme value, the three-parameter log-normal and the log Pearson III distributions. The differences between them are likely less than the errors associated with the estimation of floods for the years with no data. The results of the three-parameter log-normal analysis are illustrated in Figure 21.

No analyses were done for minimum flow data for this station since the low flow regime of winter is modified by water releases from Duncan Lake reservoir.

4.3.5 McCrae River and Duncan Lake Storage Reservoir:

As noted earlier, in most winters the water supply for Nerco Con hydro plant is augmented by releases from Duncan Lake. The control structure at Duncan Lake outlet consists of a stop-log control gate with room for 15 ten-inch logs, of which 14 are in routine use. Next to it is a concrete spillway designed to pass flood flows. Documentation of river flows in the McCrae River below the structure has recently been agreed upon

figure 21

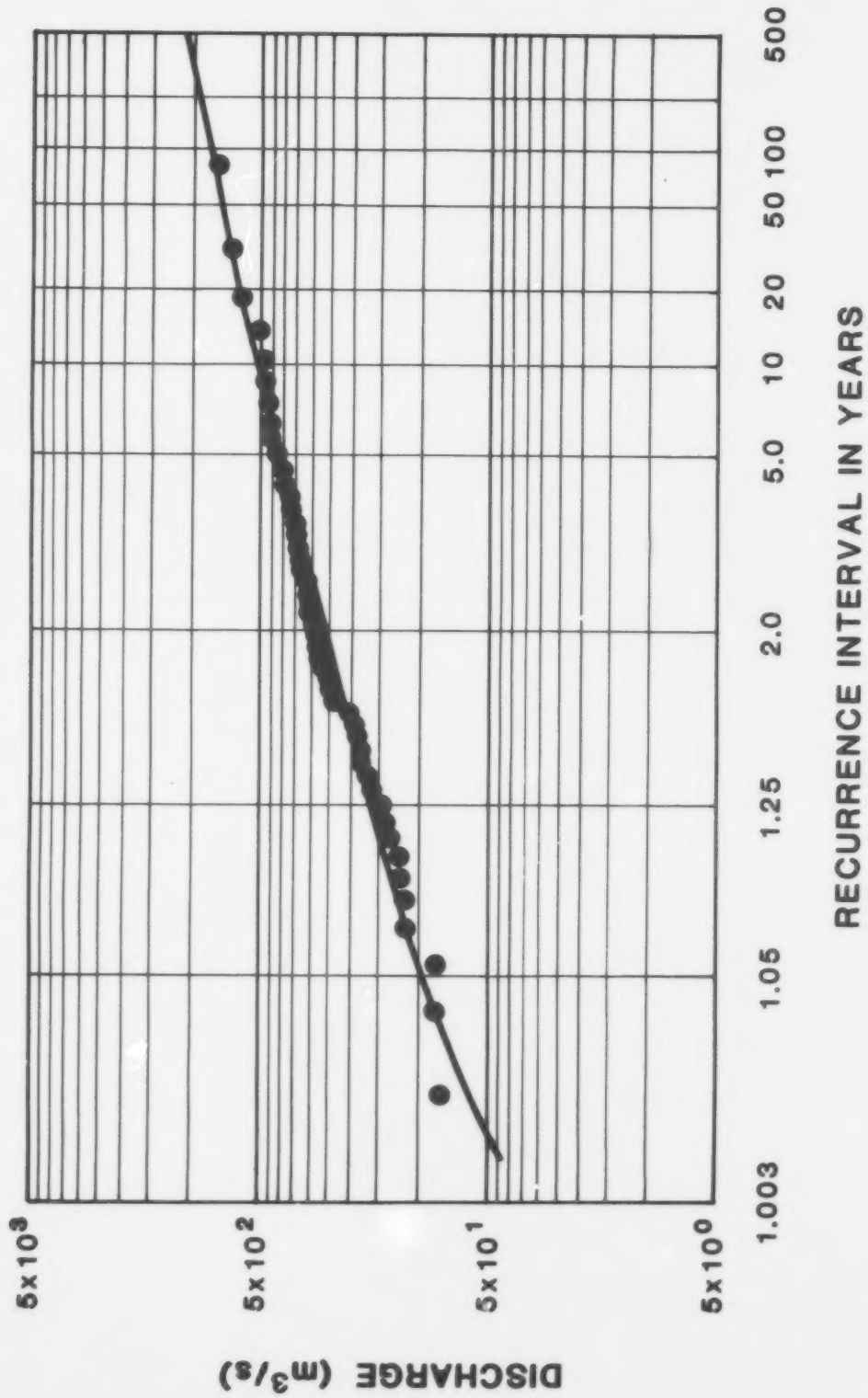


FIGURE 21. ANNUAL FLOODS, 07SB003, FREQUENCY ANALYSIS

by Nerco Con, DIAND and IWD. The formal agreement assigns responsibility for flow measurement, water level gauge maintenance and data computations to WSC of Inland Waters Directorate. A number of streamflow measurements have been made in 1988 at various log settings. A new water level station was also established on Duncan Lake. It is expected that the hydraulic ratings used until 1988 will form the basis for the comprehensive rating program now underway. Once the rating program is completed, the on-going program will require information on storage changes for Duncan Lake in order to compute flows under natural conditions. A storage curve, derived from map analysis and historic water level data, is presented here as Figure 22. The data in the figure are founded upon the following assumptions:

1. Full supply level (FSL) is the elevation of the spillway weir crest, 22.65 m.
2. The normal operating range of the stop-log control gate ranges between 2 and 12 logs.
3. Zero live storage occurs at elevation 20 m.
4. The photography used in map development, dated June, 1970 and June, 1978, was made when Duncan Lake was at FSL.
5. Duncan Lake surface area varies between 70.4 km² in flood and 69.4 km² at zero live storage condition.

figure 22

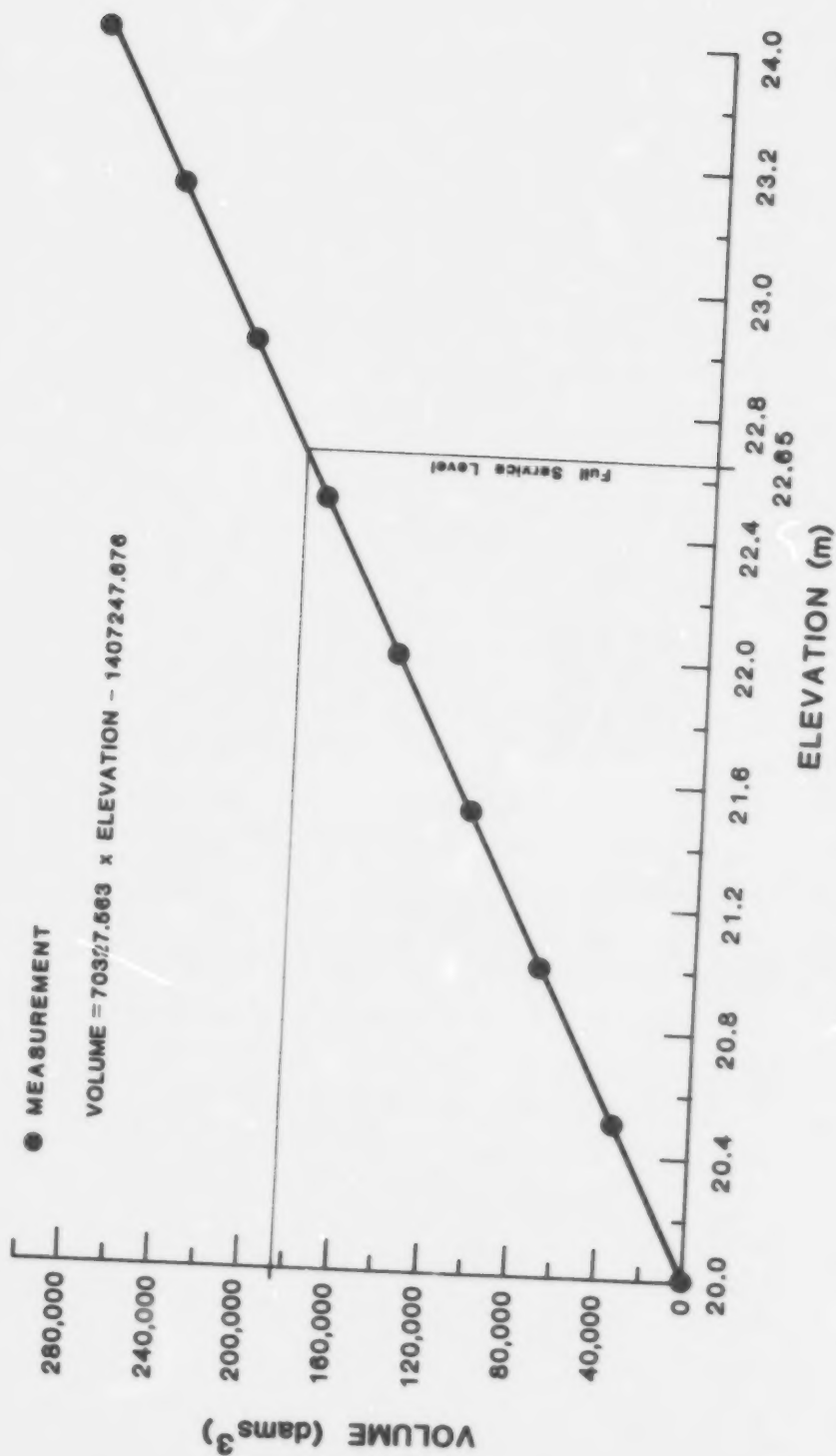


FIGURE 22. DUNCAN LAKE STORAGE CURVE

Data in Figure 22 suggest that usable live storage at FSL, 22.65 m, is 185,000,000 m³. This would support a steady state outflow of 10 m³/s from Duncan Lake for 214 days.

4.3.6 Yellowknife River at Outlet from Prosperous Lake:

Historic streamflow data for this site begins in June, 1937 and ends in September, 1940. Total annual flow is available for only 1938; the other data years are not complete. The station was reactivated in 1984 with a miscellaneous streamflow and water level program because the river was at historic high levels and future data needs for this site were anticipated. The miscellaneous program produced a Prosperous Lake outlet rating, Figure 23, where the stage component was collected on a small island in Prosperous Lake. The gauge site was upgraded to a continuous water level station in May, 1987. Continuous flow data and Prosperous Lake water levels are available from that date; see Appendix A for the station description. Data from a manual staff gauge at the water level station, beginning in July, 1986 has been used to extend the record back to July 1, 1986. The data from July in 1986 are the highest on record, exceeding those of 1984, when the current program was begun. The developed estimates, from July 1, 1986 to May 4, 1987 are considered to be quite good, with a probable error of approximately 5%. From Figure 23 it can be observed that the range of Prosperous Lake elevations in the years 1984 to 1988 was between 22.0 and 23.8 m. It is likely that the

figure 23

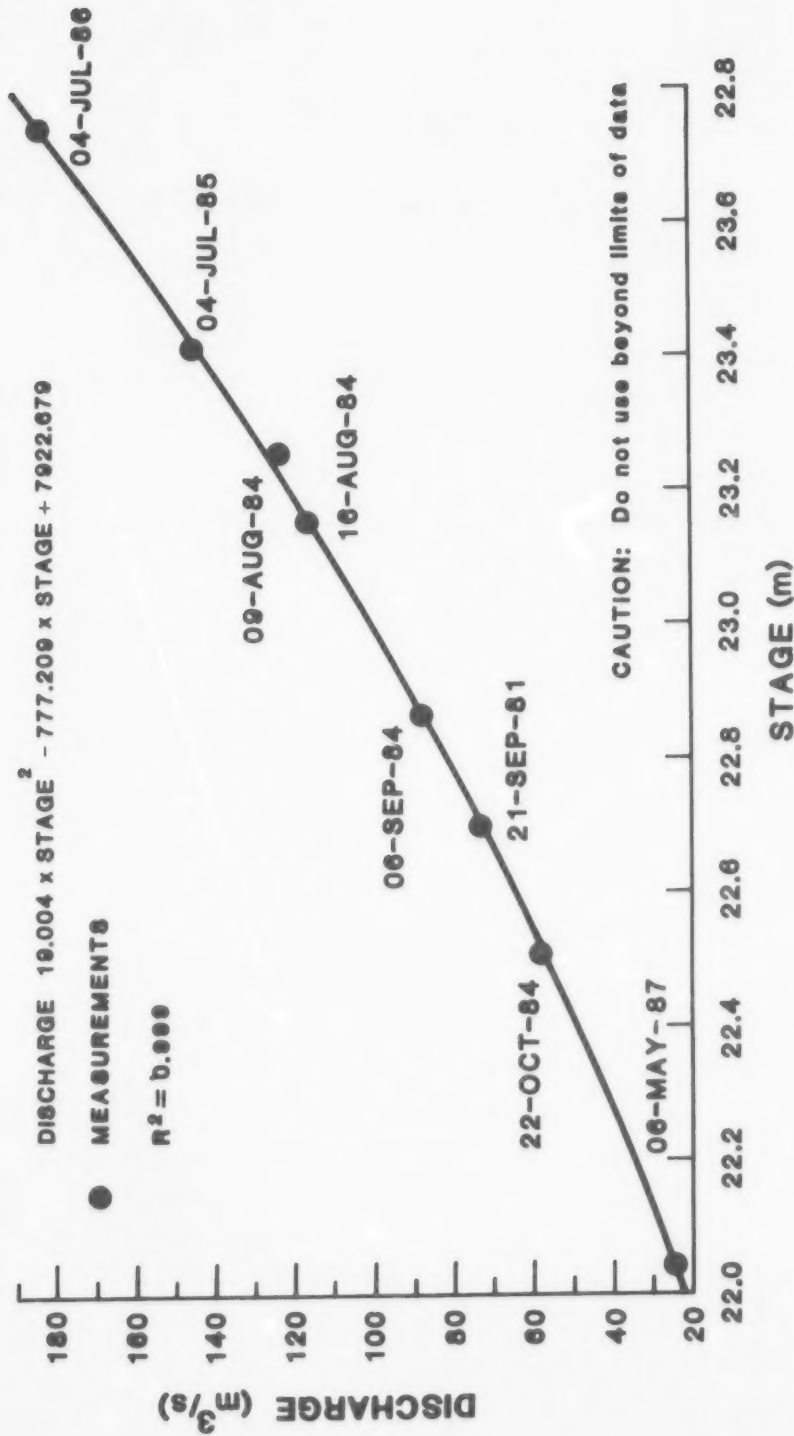


FIGURE 23. FLOW RATING - YELLOWKNIFE RIVER BELOW PROSPEROUS LAKE

historic range, estimated from high water marks and the point of zero flow at Tartan Rapids, is between 21.5 and 24.5 m, a total of 3.0 m. The river outlet flow, derived from this estimate and the rating in Figure 23, would range between 10.0 and 280 m³/s. Flood flows from the hydrometric program in 1984, 1985, 1986 and 1988 will be of considerable value in eventual analysis of extreme events.

4.3.7 Flow Comparisons:

Analysis of preliminary 1988 data from the three lower hydrometric stations, two on the Yellowknife River and one on the Cameron, suggest that the system will probably be amenable to modelling. Figure 24 is a schematic of the three lower stations and how they interrelate. A streamflow accounting program, SAP, (Shiau and Steingass, 1985) was used to compare the inflow of Prosperous Lake data with its outflow. Figure 25 shows the initial output. It can be observed that inflow to Prosperous Lake exceeds outflow until July 28; thereafter outflow is greater than inflow. In other words, Prosperous Lake water levels continued to rise until July 28 and then fell. The actual record shows that the peak water levels on the lake occurred on August 2. The simple model generated by SAP can be refined by considering time-of-travel, especially for Cameron River flow and by measuring changes in storage in Prelude and Prosperous lakes. As it stands, the SAP model links the three stations well enough to allow estimates of daily flow to be made for one site if the other two sets of data are available.

Reliable hydrologic models are invaluable tools in river basin management. They permit the manager to predict periods of high or low flow, to define limits of water utilization within environmental guidelines for different parts of the basin, and to resolve conflicting water demands such as might occur in the Yellowknife basin between mining, hydro-electric and recreational water needs. The end-result of different development and management scenarios could easily and cost-effectively be evaluated.

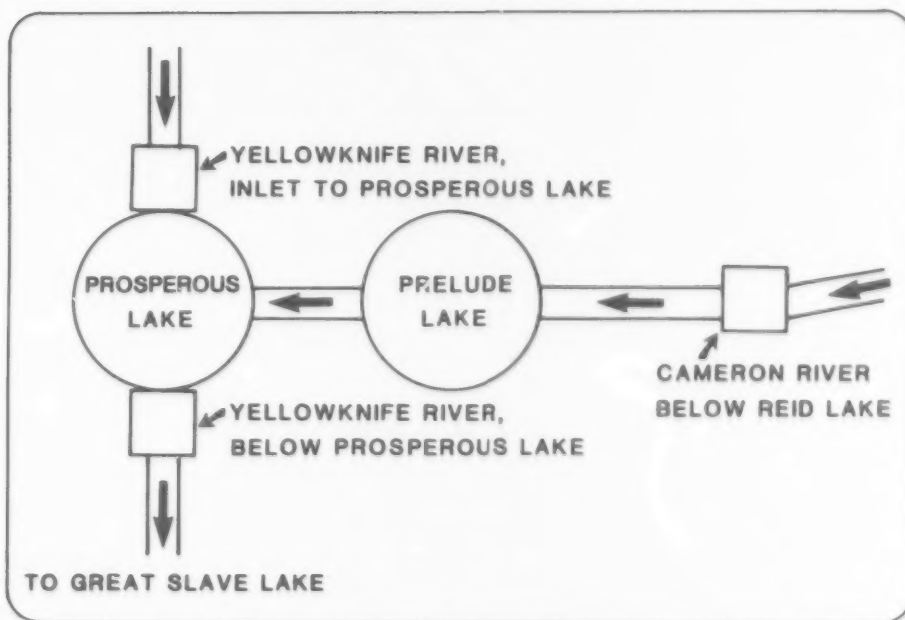


FIGURE 24. LOWER BASIN FLOW SCHEMATIC

figure 25

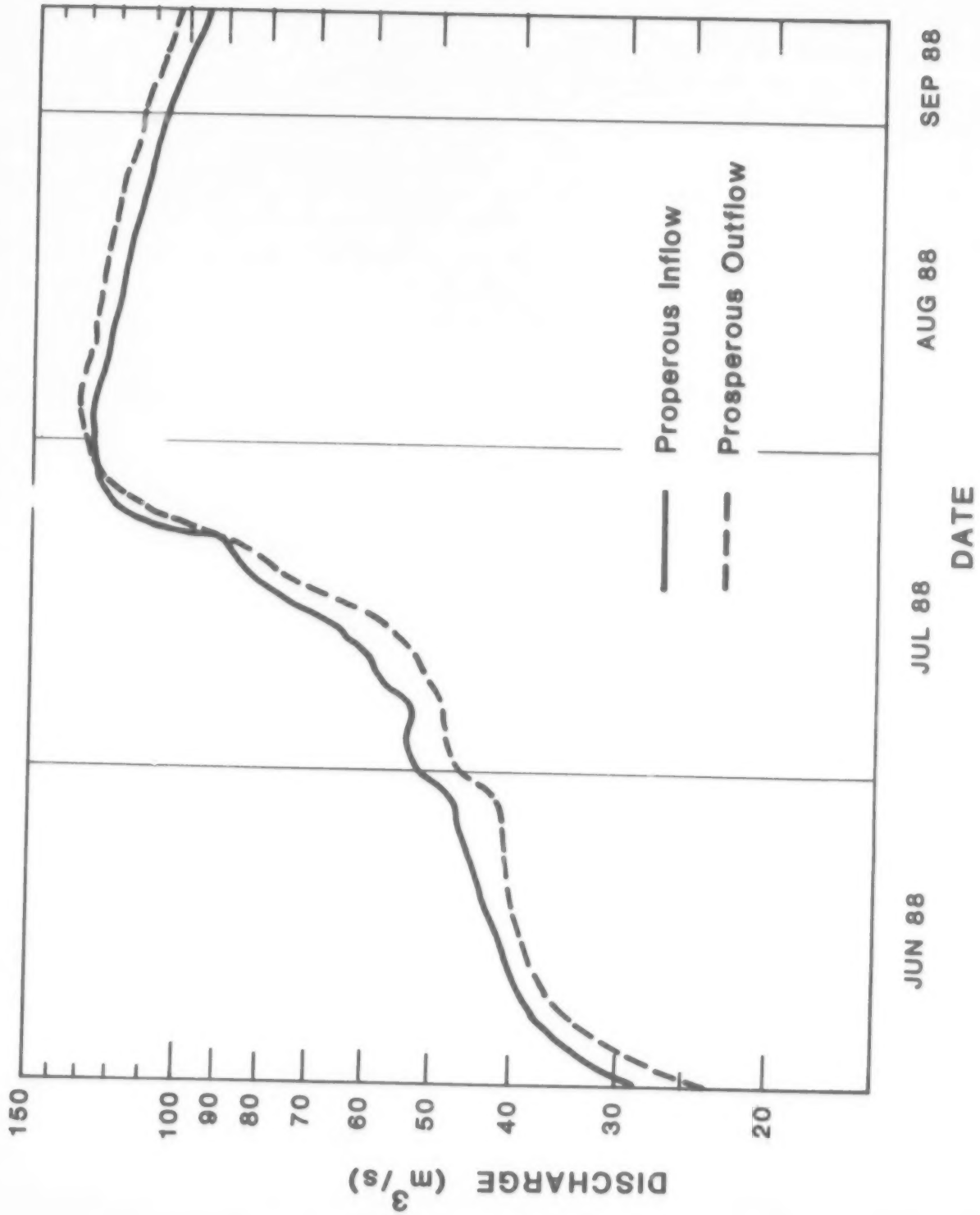


FIGURE 25. STREAMFLOW ACCOUNTING ANALYSIS - LOWER BASIN

5.0 CONCLUSIONS AND RECOMMENDATIONS:

The Yellowknife River basin is a small basin of 15,900 km² in the tundra-taiga transition zone. It is of interest to hydrologists because the fraction of annual precipitation which becomes streamflow roughly doubles from forest to tundra - approximately from 0.20 to 0.40. The basin is located near the northwestern borderlands of the Canadian Shield. The drainage patterns of its watercourses are dictated by bedrock geology and by glacial debris. Bedrock influence dominates. For example, the mainstem of the Yellowknife River flows along the western margin of the basin instead of down its middle. Hundreds of linear structures are evident in river and lake systems in the basin; the most dramatic is the 'T' configuration of the McCrae River in the heart of the basin.

The basin is host to a variety of human activities. Metal mining, mainly for gold, has been an ongoing activity for 50+ years. Little impact from mining is evident on system water quality, but other contamination exists. Erosion of Discovery Mine tailings on the west shore of Giauque Lake, has contaminated lake sediments with mercury and arsenic, but no statistically significant differences were found in water quality samples made above and below the lake in 1987. Contamination, however, has found its way into the food chain; studies in the late 1970's showed that fish in Giauque Lake were heavily contaminated by mercury in 1978. The studies also showed that fish in waterways above and below Giauque Lake were not significantly contaminated. Because Discovery Mine contamination of fish is of relevance to subsistence and recreational activities in the Yellowknife River system downstream from Giauque Lake,

(1) it is recommended that periodic sampling of fish in Giauque Lake and downstream be incorporated in basin management plans.

Recreation related to wild rivers in northern Canada has become a popular activity and generates significant economic return for the host area. These activities are common in the Yellowknife River basin, especially in the southern, more accessible portions of it. Since the attractiveness of an area influences its tourist potential,

(2) it is recommended that industrial development, e.g., mines or power plants, be urged to consider suitable aesthetic design in plant construction.

The results of the water quality reconnaissance surveys showed little variation across the basin. If further basin-wide sampling confirms these preliminary findings, a few stations upstream of existing or potential developments to monitor natural background water quality parameters would therefore probably suffice. They should operate year-round in order to describe seasonal variability. The stations could also be used to monitor changes in water quality over the long term from air-borne pollutants. These index stations should be supplemented by project specific stations sited so as to monitor the impact of major developments within the basin. Data from these sites need only address the concerns associated with the activity in question. Accordingly,

(3) it is recommended that index water quality stations be located within the Yellowknife River basin in catchments with no foreseeable development.

(4) it is recommended that a water management network of water quality stations be designed which would measure the impacts of development on the waters of the Yellowknife River system. The parameters measured should be linked to the character of waste discharges or other licensed water use projects upstream of a sampling site.

Analysis of water quantity in this document consisted of extreme value analysis of annual yield and annual floods for Cameron River below Reid Lake, 07SB010; and for Yellowknife River at Inlet to Prosperous Lake. In the case of the Cameron River, the confidence in the results is diminished because record is available for only 12 years. Since these data are essential to water resource management for the larger Yellowknife River basin,

(5) it is recommended that Cameron River data collection continue for at least eight more years, preferably 13 more, so that a statistically valid sample size for extreme value analysis can be assembled for this site.

Data from the Yellowknife River station is much longer in duration, but it is not of the same quality as conventional IWD data. The historic record was contributed by Cominco and it consists of output from hydraulic power plant ratings. These ratings are not in agreement with coincident data generated by the WSC hydrometric program in 1988. The plant hydraulic data are consistently less than data produced by WSC. Since these differences were systematic rather than random, the extreme value analyses which were done and reported upon elsewhere in this report are probably inaccurate. Since these data are of great

value because of their length,

(6) it is recommended that Nerco Con and WSC continue to work towards resolution of flow differences between their calculated data. Once resolved, the historic record should be updated. Its length gives the record great value, especially in development of river basin management strategies.

Eventually, basin managers will need to develop a reliable model of streamflow for the Yellowknife basin. A very simple, additive model of the relationship between Cameron River and the Yellowknife River stations above and below Prosperous Lake suggests that development of a more comprehensive model of flow behaviour in the basin should be possible. Additional data will be needed, but generally only for the short term - say three to five years. A program to generate outflow and changes in storage for Duncan Lake is now underway, courtesy of Nerco Con who require the data for power plant operation. Model development will also need these data in order to compute natural flows for this drainage. Other additional stations needed for development of a basin model, are suggested for the Surprise River in the northern basin, either Nardin or Frodsham small basins, and on the Ross River in the southeastern portion of the Yellowknife basin. The reconnaissance data from both the upper McCrae and Nicholson rivers above Duncan Lake suggest flow behaviour at variance with the rest of the basin. It may be necessary to operate a short-term streamflow station on at least one of them to verify the Duncan Lake inflow-outflow data sets now being assembled. Accordingly,

(7) it is recommended that new, short-term hydrometric stations be established in the initial phase of basin planning at the following locations:

- (a) Surprise River above Yellowknife River
- upper basin tundra catchment
- (b) Nardin or Frodsham rivers above Yellowknife River
- mid-basin, small, lake-dominated
- (c) Ross River above Cameron River
- south-east basin runoff, less than elsewhere.
- (d) McCrae River below Duncan Lake
- significant mid-basin catchment
- (e) McCrae or Nicholson rivers above Duncan Lake.

Following development of an outflow rating on the McCrae River below Duncan Lake and attendant storage data for the lake itself, a short-term hydrometric station should be operated for a few years on either the Nicholson or Upper McCrae rivers above Duncan Lake. These data would serve to verify an important module, the McCrae River system, in the proposed model. Accordingly,

(8) it is recommended that a Yellowknife River basin flow model be developed as data become available.

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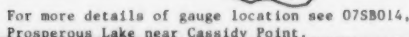
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--A1--

APPENDIX A

Station Descriptions of
Yellowknife River Basin WSC Stations

NOTE: The access to this station is by boat during the open water season. During the winter access is by snowmobile from Cassidy Point. It is dangerous to go through the narrows at the entrance to McMeekan Bay as the ice remains thin.



DESCRIPTION OF STATION

Description of Geologic Environment and Location

A manometer-activated A-71 recorder housed in a
wooden shelter on an unnamed island in Prosperous
Lake.

Recreation of Control & Measuring Systems

The control is the Tartan Rapids at outlet of Prosperous Lake. Discharge measurements are made under the bridge where Hwy. #4 crosses the Yellowknife River, 12.6 ^{km} below Tartan Rapids. River has open water rating during the winter.

Prepared by K.L. Epp Date May 29, 1990

ELEVATION OF GAUGE DATUM AND DESCRIPTION OF BENCH MARK

Elevations are referred to GSC Datum.

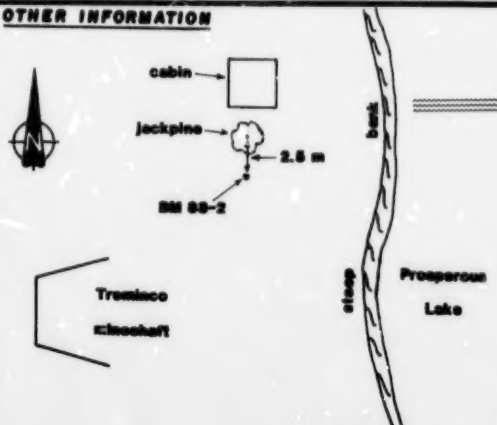
BM 84-1 Brass cap in bedrock on West point of island,
marked by iron rod (BM marked NTS L1049)

Elev. 161.502 m

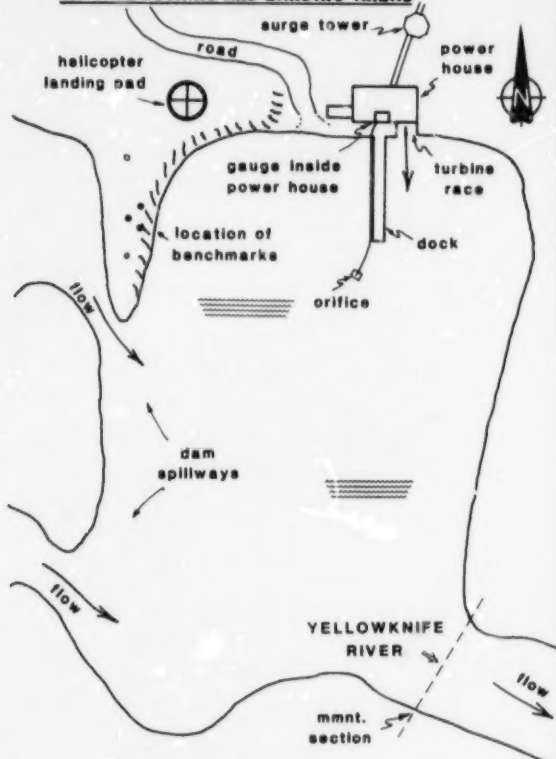
BM 88-2 A paint mark on bedrock on East Shore of Cassidy Point near the mineshaft 2.5 m south of jackpine marked with flagging.

Elev. 162.251 m

OTHER INFORMATION



**SKETCH SHOWING LOCATION OF BENCH MARKS
AND GAUGING EQUIPMENT.
INDICATE DOCKING AND LANDING AREAS.**



**ENVIRONMENT CANADA
WATER SURVEY OF CANADA**

DESCRIPTION OF STATION

Station No. 07SB003 Drainage Area 11 300km²
Station Name Yellowknife River at Inlet to Prosperous
Lake
Province N.W.T.
Latitude 62° 40' 18" Longitude 114° 15' 40"
Established April 21, 1988 by D.D. Ross

Description of Gauging Equipment and Location

A servo-manometer and recorder are housed inside the power house at the Nerco Bluefish hydro generation station, below Bluefish Lake. The station is located 26km NE of Yellowknife by air. Access is by ice-road during winter and by helicopter or boat during the rest of the year.

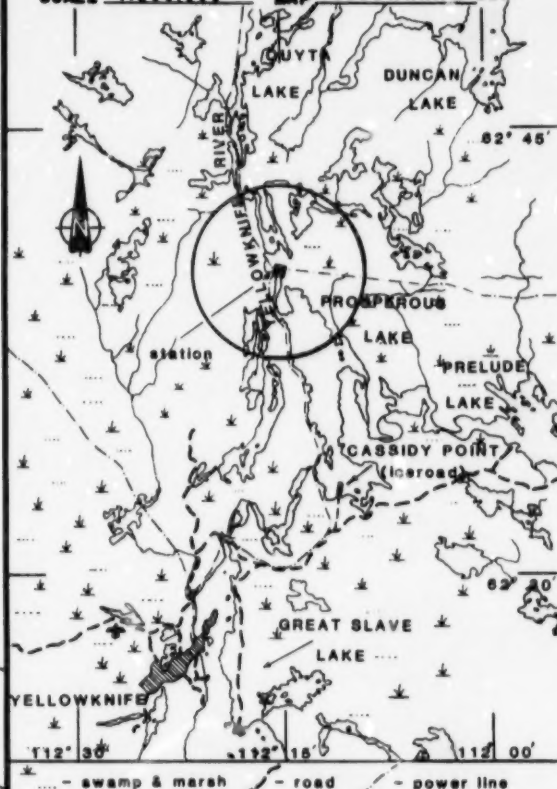
Water level can be obtained by calling Nerco Power House, 873-2357.

Description of Control & Measuring Station

Sectional control is bedrock rapids below tail race. Flows are subject to regulation by dams at Bluefish Lake and at outlet of Duncan Lake. Measurements are made by boat above rapids.

Prepared by K.L. Epp Date 1989 10 03

**SKETCH OF STATION LOCATION
SCALE 1:250,000 MAP YELLOWKNIFE 86J**

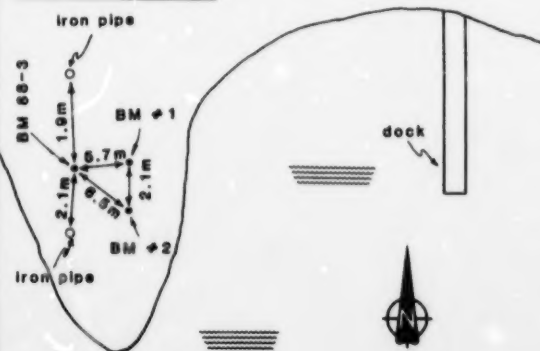


**ELEVATION OF GAUGE DATUM AND DESCRIPTION OF
BENCH MARKS**

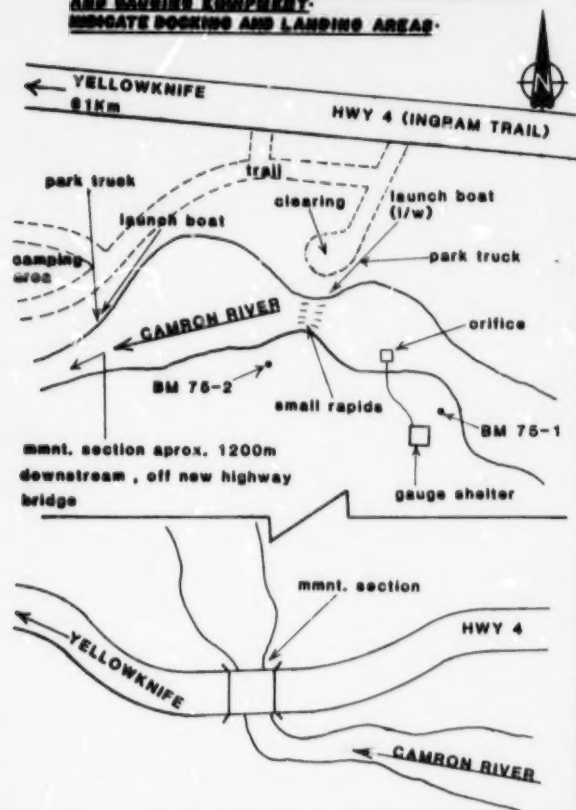
Height of Gauge Datum 0.000 m. assumed
Conversion Convention in meters to
Nerco Mines Datum

BM#1	Paint mark on rock located 2.1m N of BM#2 and 5.7m E of BM 88-3.	ELEV.155.565m
BM#2	Brass cap located in bedrock 2.1 m S of BM#1 and 6.5m SE of BM 88-3.	ELEV.155.637m
BM 88-3	Brass cap located in bedrock 5.7m W of BM#1, 6.5m NW of BM#2 and between two iron pipes.	ELEV.156.844m

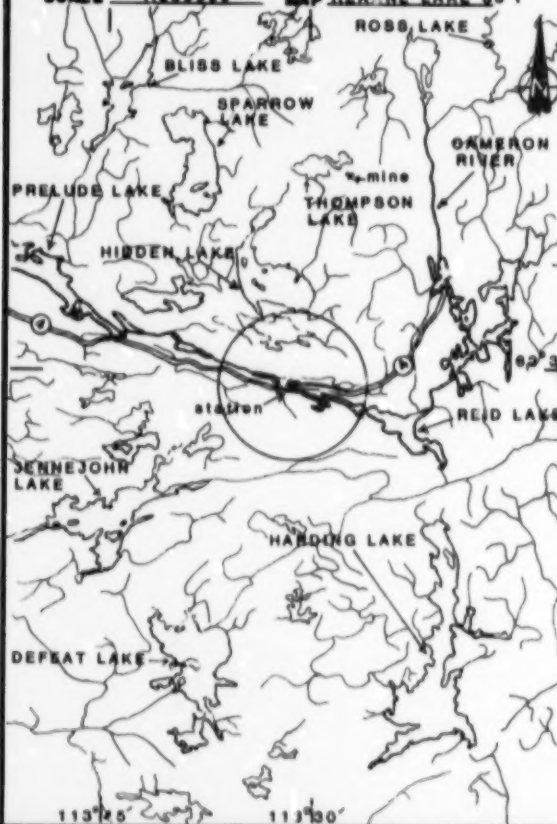
OTHER INFORMATION



**SKETCH SHOWING LOCATION OF BENCH MARKS
AND GAUGING EQUIPMENT.
INDICATE DOCKING AND LANDING AREAS.**



**SKETCH OF STATION LOCATION
SCALE 1:250000 MAP HKEARNE LAKE 85 I**



**ENVIRONMENT CANADA
WATER SURVEY OF CANADA**

DESCRIPTION OF STATION

Gauge No. 0758010 Drainage Area 3 630 km²
Station Name CAMERON RIVER BELOW REID LAKE
District NWT
Latitude 62 29 27 N Longitude 113 31 12 W
Established 1975 07 18 By E.D. Fowler

Description of Gauging Equipment and Location

Instrument shelter contains servo-manometer, recorder and data collection platform.

Station is located on LB below Reid Lake, 61.0 km from Yellowknife on Highway No. 4 (Ingram Trail) and 1,200 m upstream of highway bridge.

Description of Control & Measuring Station

Stable bedrock control at rapids 20.0 m below gauge. Measurements are obtained at highway bridge or by wading at foot of rapids below gauge.

Discharge relationship unaffected by ice.

Prepared by D.J. Dube Date 1989 10 03

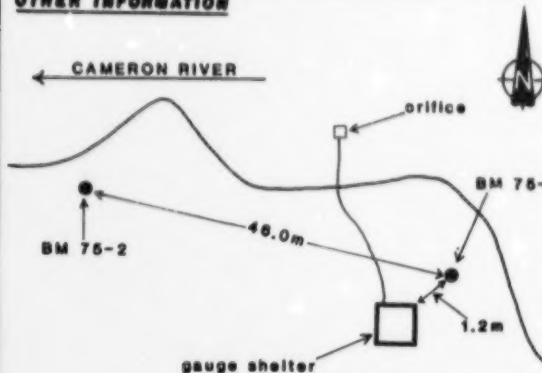
ELEVATION OF GAUGE DATUM AND DESCRIPTION OF BENCH MARKS

Elevation of Gauge Datum 0.000 m, assumed
Converting Equation +210.312 to convert to GSC datum
DCP I.D. #454885FO, 02:41, 10W, 130/138°

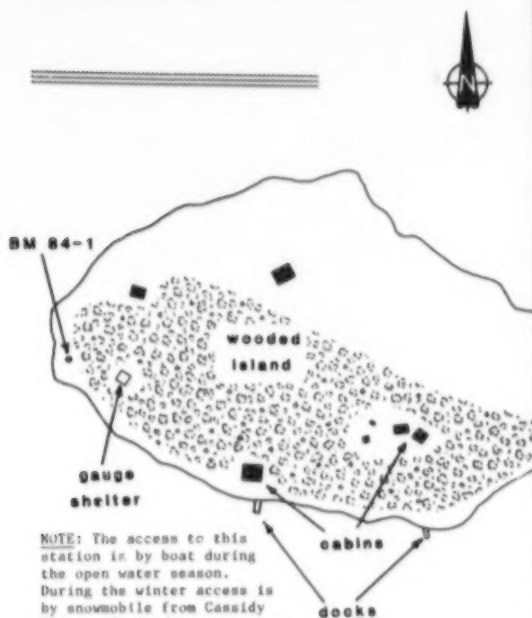
BM 75-1 Brass cap in bedrock 1.2 m north of shelter. 4.288 m
BM 75-2 Brass cap in bedrock 46.0 m downstream from BM 75-1. 3.429 m

Bench marks referenced to Monument C-19 = 234.891 m

OTHER INFORMATION



**SKETCH SHOWING LOCATION OF BENCH MARKS
AND GAUGING EQUIPMENT.
INDICATE DOCKING AND LANDING AREAS.**



NOTE: The access to this station is by boat during the open water season. During the winter access is by snowmobile from Cassidy Point. It is dangerous to go through the narrows at the entrance to McMeekan Bay as the ice remains thin.

See also Station 07SB002, Yellowknife River at outlet of Prosperous Lake.

**ENVIRONMENT CANADA
WATER SURVEY OF CANADA**

DESCRIPTION OF STATION

Station No. 07SB014 Drainage Area ---
Station Name Prosperous Lake near McMeekan Bay
Province NWT
Latitude 62° 31' 21" N Longitude 114° 09' 31" W
Established Aug. 9, 1984 By F.J. Jackson

Description of Gauging Equipment and Location

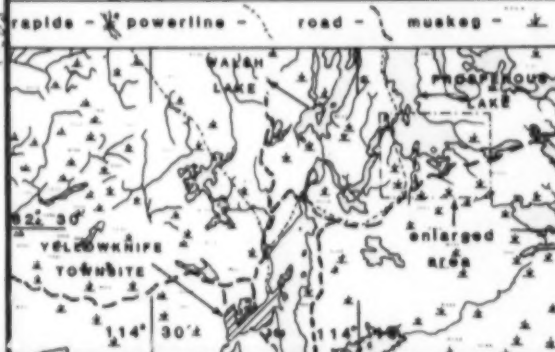
A manometer activated A-71 recorder housed in a wooden shelter on an unnamed island in Prosperous Lake.

Description of Control & Measurement Station

Water levels only are published for this Station. Discharges are published as Yellowknife River at outlet from Prosperous Lake (07SB002)

Prepared by K.L. Epp Date May 29, 1990

**SKETCH OF STATION LOCATION
SCALE 1:50,000 MAP PROSPEROUS LAKE**



ELEVATION OF GAUGE DATUM AND DESCRIPTION OF BENCH MARKS

Elevation of Gauge Datum 0.000 m m. assumed
Conversion Equation is assumed to be
Elevations are referred to GSC Datum.

BM 84-1 A brass cap in bedrock on the west point of the island marked by an iron rod. (BM marked NTS L1049)

Elev. 161.502 m

BM 88-2 A paint mark on bedrock on east shore of Cassidy Point near the mineshaft 2.5 m south of jackpine marked with flagging.

Elev. 162.251 m

OTHER INFORMATION

